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Peter A. Juley & Son

A MURAL (above) in the California School of Fine Arts, executed by Diego Rivera. This Mexican, whose work is mainly fresco, is plying his trade with astonishing approbation in the United States. Many of his subjects depict applied science and technology, a subject which he treats bluntly but revealingly. Left: "Pneumatic Drill," a new fresco by Mr. Rivera, which is on exhibition at the Museum of Modern Art in New York City

THE
TECHNOLOGY
REVIEW

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ENGINEERS AS CITY PLANNERS

Germany Finds Technical Clarity a Way to Civic Beauty

By Roman F. Heiligenthal

Translated by Hunter Rouse

THAT law of nature, called recapitulation, which states that higher forms of life must, prior to birth, pass through all the stages of evolution of their predecessors, seems to hold true for the modern art of building, just showing signs of life. Such beginnings as the London Crystal Palace of 1851, the Eiffel Tower of 1888, and the numerous bridge projects in America and Europe were unable to bring this new structural art into the world, because mankind had not attained the proper degree of maturity. Civilization still had to re-experience the entire architectural development of the Egyptians, the Greeks, and the Romans, through the Gothic and Renaissance to Baroque and Classic styles, before it could finally free itself from the past.

Germany, so historic in her tendencies, has suffered greatly under this situation, not only in structural architecture but in city planning, especially since the latter was not, as in America, in the hands of the landscape architects, but in those of the building architects. The influence of city designs of the Middle Ages, felt until the end of the Nineteenth Century, and of Baroque designs till early in the Twentieth, have seriously hindered the progress of city development.

The German engineer may take unto himself credit for having guided city planning out of this erroneous situation. From the following points of attack he has approached the problem of municipal development:

1. Questions of economics, of transportation of goods, and of intercourse.

2. Matters of water, gas, and electric supply, of drainage and sewage, of the provision of tree and park areas.

3. The problem of housing the laboring forces of great industries.

The Nineteenth Century concerned itself in no way whatsoever with the city as a center of production, but instead dealt primarily with the development of residential quarters. Planning of industrial centers was looked upon as purely technical — the planning of a residential section was an art.

German engineers, depending upon their knowledge of political and private economics, first determined that the modern municipality, contrary to the earlier cities, is not a consuming center, but a producing center; that its life forces are industry and commerce; that its development is stimulated by transportation and turnover of goods; and that its entire character may be understood only through a proper understanding of its economic functions, its labor divisions, and its labor associations.

City planning may not commence with the secondary matter of residential districts; on the contrary, its primary duty is to establish the production possibilities of the locality and thereafter so to give body to the plan that these production possibilities will be fully utilized.

The means thereof lie in the transportation system; the skeleton of riverways and railways determines the figure of the modern city. This figure is subject to continuous growth and remodeling, since the modern city is no longer the economic center of a small region, but an arm of the economic world and an object of its extraordinarily far-reaching influences.

Not static as was the city of the Eighteenth Century, planned and built after a fixed design, but dynamic — thus must the modern municipal organism be understood; for its life signifies not only constant growth, but also death for many sections. Its plan must be essentially elastic.

The great designs submitted in prize planning contests for Berlin in 1910, for Düsseldorf in 1912, for Breslau in 1921, and for Wetzlar in 1925 stand as a symbol of this development. The systems of intercourse in these designs concentrate entirely upon furthering the productive processes of the city, and giving the laborers peace after the turmoil of the day.

That the commercial centers are the disturbing element in the municipal design — as taught by Romanticists and Classicists at the turn of the century — is a fallacy. On the contrary, while the Nineteenth Century sponsored the ring scheme of the old fortified towns, the radial development of the modern city was first brought about by demands of intercourse. Only as a result of the introduction of street cars in municipal traffic did the difference between thoroughfares and residential streets become apparent. Thus the modern city found that form expressive of its organization. Commerce has led the way out of the maze created by speculation and architectural fantasy and, above all, has made possible the process of crystallization of the modern city system.

In the field of street design the *Studiengesellschaft für Automobilstrassenbau* (Society for the Study of Automobile Highway Construction) has played a most prominent part. This association has evolved a plan of a network of main highways for entire Germany, which will be followed as closely as the unfortunately meager funds will permit. It has also established standard cross-sections for a multitude of different sorts of highways and streets, which are of extreme value not only for regional planning, but for city design in the narrower sense as well. It has finally proved in how high a measure the street cross-section is determined by the relation of through traffic to local traffic, which changes according to the varying agglomeration of its economic character.

Through the work of the engineers for water, gas, and electric supply as well as those for sanitation in industrial districts, regional planning has come into existence. German engineers have not only technically solved their problems of water supply and sanitation (*Imhofftanks*) but they have also stimulated the solution of these problems within the widest limits for entire economic districts and drainage regions. Finally they have also sponsored legislation favoring the progress of their efforts.

This legislation, which has made its mark upon German regional work, recognizes an association of certain groups and organizations (*Zweckverband*) based upon a special law. Unenforced coöperation of the community with technical experts serves to clarify the economic and technical bases for, and to further develop the matter in law leading to, a closer bond between these groups. Stronger regulations are considered than are necessary for the completion of projects, in order to establish firmly their various rights and duties, and to simplify relations with the courts and so obviate disputes.

In this way the great union for the water supply of the Ruhr district was created as early as 1898; the Emscher Association in 1904 for flood control, drainage, and the purification of the drained water in the Emscher region; and the Ruhr Union of 1913, which attends to these problems in the region where the collective waters of the Ruhr flow off.

This *Zweckverband*, through passage of special laws, proved itself of such merit in the Ruhr region that it has also been used for regional planning in the field of city design, for the Ruhr Settlement Union was formed in 1920, also by special law. In this case as well, the association by law was preceded by years of uncompulsory cooperation between the community and the state officials and technical experts, in order to clarify the underlying principles and work out the matter in judicial terms.

As source of this work there existed the wish to retain the recreational sections of the Ruhr district threatened by the development of industries. It soon became obvious, principally through the efforts of Dr. Ing. Schmidt, that it was not possible to rely upon the negative inertia of park spaces for their preservation, without providing positive means for the expansion of industries and for the layout of residential quarters and routes of intercourse. As a result, the Ruhr Settlement Union is armed with court authorization for the construction of traffic channels, for zoning, settlement, and the provision and preservation of free spaces.

The realization that useful economic politics are only possible if the basic principles of social hygiene are observed has led to the establishment of large planted areas even in the centers of the largest cities.

In Berlin there are expansive open spaces provided in the suburbs for drainage and gardening purposes. The sand districts of the plains of Brandenburg were transformed into irrigated lands to take up the drainage of the city and to lighten the problems of milk and vegetable supply. Adjacent to these great farming lands were provided expansive recreational fields for the community through acquisition from state and private ownership of wooded sections which surround the most beautiful scenic territory, in particular that of the lake region.

So far as these large open spaces of the community may serve tourists, they are also used to promote agriculture and forestry — but always in such a way that the goals of recreational facility and scenic beauty are first considered.

In conjunction with the large open suburban areas and the inner city parks, the example set by America in providing grass strips along street and sidewalk has had a strong influence in Germany. It has also been realized that the present-day parks may no longer be designed in the style of the fashionable court gardens of the Eighteenth Century, since they must serve huge throngs as playgrounds. These, together with sport and swimming parks, are now planned in great numbers and area.

The settling of laboring classes in expansive settlement districts has been an (*Concluded on page 222*)

BACK TO LEIBNIZ!

Physics Reoccupies an Abandoned Position

By Norbert Wiener

IT IS a commonplace of the present decade that physics is in a state of turmoil. Almost all of the grand structure which the physicists of the Eighteenth and Nineteenth Centuries reared remains standing in some form or other, but the logical foundation on which it has been erected has been undermined on all sides. We are far more confident of the validity of ordinary engineering computations, within ordinary engineering limits, than of any form of the laws of motion. The unquestioned dominance of the Newtonian physics is a thing of the past, and up to the present, no form of relativity, or quantum theory, or wave mechanics has been able to assume that logical completeness which characterized the foundations of the physics of our grandfathers.

In the present dilemma, it is very well worth while to call history to our aid and to compare the state of mind of the present period with that of other periods of doubt and confusion. This historical attitude in science, it is true, is suspect to many of our more "tough-minded" contemporaries. What does the stupid repetition of the blunders of the past, they will say, have to do with so live and growing a subject as science? Science is — or at least I imagine the up-to-date reader of outlines, symposia, and digests will claim that it is — the utter antithesis of such intellectual activities as metaphysics, which spirals around in a continual reoccupation of abandoned positions, and which has an interesting history only because it has a dead future. Science is progressive, we are told, and when it once outlives a primitive stage, that stage is past for all time. This view is held by many readers of popularized science, by most of those who proffer Mr. Einstein the keys of cities, and here and there, I am sorry to say, by some misguided *Fachbruder*.

Nevertheless, in considering the present period of intellectual chaos, I do find it profitable to return to the times before Newton, or at the very latest, to the times when Newtonian physics was itself but one alternative theory struggling for recognition. Besides Newton himself, the greatest names of this period are those of the Dutch physicist, Christian Huyghens, and of the German mathematician-physicist-philosopher-statesman, Gottfried Wilhelm Leibniz. These two scholars were in close communication with each other. As few people realize, the Leibnizian work, done largely under the influence of Huyghens, possesses a startling modernity.

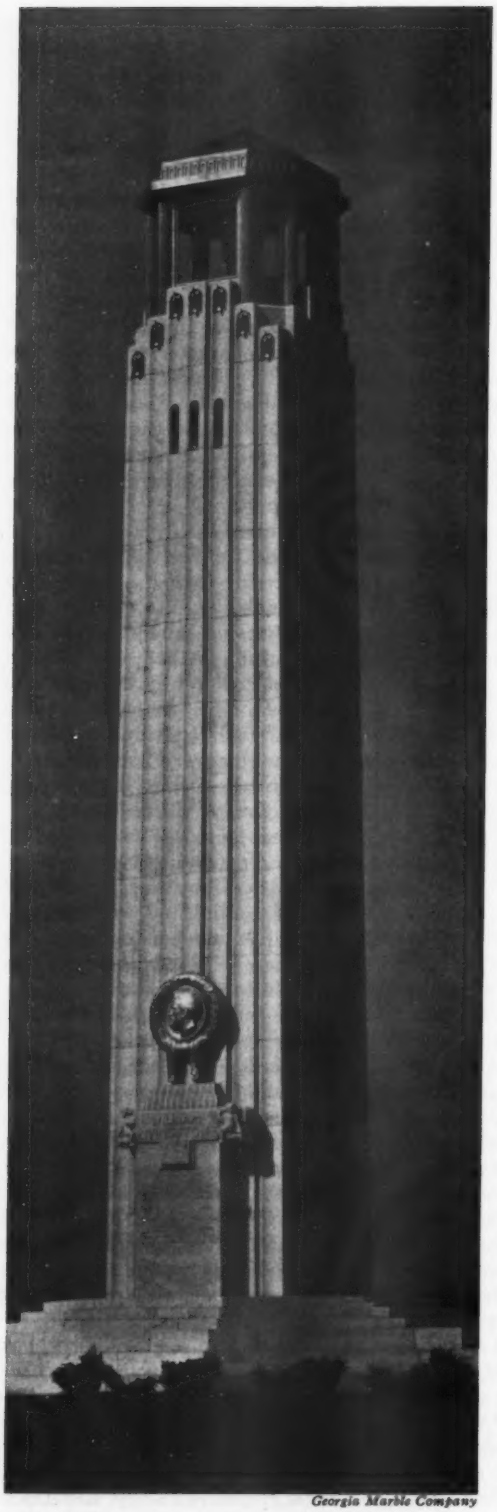
Leibnizian physics contains many startlingly modern ideas. For 200 years his views were eclipsed by the Newtonian system and it was not until the beginning of the present century that the technique of physical observation became sufficiently developed to suggest serious shortcomings in Newtonian mechanics.

Leibniz wrote at the termination of the pre-Newtonian period of groping and confusion, and it is now the post-Newtonian period of groping and confusion in which physics is enveloped. Thus, physicists are again prepared to find more suggestion in general philosophical considerations, such as those of Leibniz, than in Newton's great, finished discipline which the years have squeezed dry.

Leibniz stands unique in intellectual history. From the invention of computing machines to the collection of the remains of the dying Polabian language and from the discovery of the calculus to an attempted redintegration of Christendom, there is no aspect of scholarship which he did not touch and adorn. Despite the fact that there is but little to admire in his character — he had the flexible back of a courtier, and was more than once mean and disingenuous in his relations with other scholars — by the sheer force of his intellect and the bulk of his achievements, he stands out from the intellectual barrenness of the Germany that lies between the devastation of the Thirty Years' War and the revival of the mid-Eighteenth Century as an Alp amid molehills. Yet of all his vast contributions, almost none saw its fruition either in his own publications or in those of his disciples. The symbolism of the Infinitesimal Calculus is indeed his: the discovery itself he shares with Newton. His invention of determinants, his studies in mathematical logic and universal languages, his computing machines, his plans for the invasion of Egypt — all these were left for other and independent hands to complete and make real. The physical suggestions which form the object of this note were obscured by the more finished work of Newton, and have lain fallow for more than 200 years.

That all this work was sterile and unfinished is to be attributed to the fact that Leibniz was a very busy man. As archivist of the Hanoverian court and historiographer to the dynasty, he spent in the cataloguing and compilation of relatively insignificant genealogical information, the time that he might have devoted to his universal studies. And this universal genius — the last of whom it was truly to be said that he took all knowledge as his province — considered himself fully compensated by the opportunities he found to converse with royalty, and the royalty of Thackeray's four Georges at that!

As Leibniz was to some extent a disciple of Huyghens, the Leibnizian physics must be understood on the basis of the contributions of the latter. Huyghens, in turn, is best to be understood by comparing his work with that of Newton. The most famous point on which Huyghens and Newton differed is their theory of light. Huyghens was the father of the wave theory, and it is to him that we owe the famous "Principle of Huyghens" which asserts that each point on the front of a wave acts as a center of disturbance in the formation of a new



Georgia Marble Company

The William Livingstone Memorial lighthouse, near Detroit, Mich., erected by the citizens of Detroit and the Lake Carriers Association, of which organization Mr. Livingstone was President from 1902 to 1925

wave. Newton, on the other hand, held to a particle theory of light. Light for him consisted in a stream of particles of various velocities emitted from the source of illumination and he explained the phenomenon of refraction by "fits of easy and difficult transmission" on the part of the transmitting medium. During the Eighteenth Century, Newton's fame and the success of his mechanics completely eclipsed the work of Huyghens, but during the Nineteenth Century, the rôles were reversed and the study of the phenomenon of diffraction established a wave theory of light as the accepted view. At present, the situation is extremely confused. From certain standpoints, we know that a particle theory is demanded, while from others all the original arguments of the exponents of the wave theory remain valid.

FOR neither the wave theory nor the particle theory of light was a complete mathematical exposition possible at the time of Huyghens. The particle theory of light belongs, of course, with the particle dynamics of Newton, and demands the study of the ordinary differential equation. The differential and integral calculus which furnish the proper tool for this purpose were both established independently by Newton and by Leibniz. On the other hand, the proper tool for the treatment of any wave theory is the theory of the partial differential equation, and this is considerably more difficult. In the course of the Eighteenth Century this theory, too, was developed largely by the Bernoullis and later by Laplace and Lagrange so that when the wave theory came into vogue in the Nineteenth Century, the necessary machinery was in existence. What I wish to make clear, then, is that at the time of Leibniz neither the mechanics of the particle nor optics were in possession of their full mathematical machinery. It was by no means obvious which path physics was to take. The path chosen by Newton — the mechanics of a particle — involves as a necessary hypothesis action at a distance. The particle, which may be viewed by abstraction as a mathematical point is subject to forces, gravitational and otherwise, emanating from other particles remote in space, and traversing empty space, or vacuum, before arriving at the particle to be moved. On the other hand, the physics of wave motion presupposes a continuous medium through which all influences pass, and at least makes it plausible that these influences consume time in passing.

As I have said, this antinomy between particle and wave is incompletely resolved at the present time. Our electrons behave much as particles and somewhat as waves. Our photons, or light-quanta, behave much as waves and somewhat as particles. It is interesting to observe that the same opposition of these two seemingly irreconcilable views plays a most prominent part in the philosophy of Leibniz. Leibniz definitely abjured the vacuum and all action at a distance. On the other hand, he definitely believed in the existence of discrete monads, or soul-like entities, seemingly acting on one another. Again, the real activity of these monads was supposed by him to be one of perception. Each monad, he says, mirrors the whole world of other monads. Some mirror it more clearly and distinctly; others, more vaguely, confusedly, and obscurely. It does not require much imagination to see an analogy between this mirroring activity of the monad which appears to our confused vision like a causal activity, emanating from one monad and impinging on the other, and the modern view in which the chief activity of the electrons consists in radiating to one another.

This analogy may be carried out in a certain degree of detail. As I have said, some of the Leibnizian monads mirror the world more clearly, some less clearly. This lack of clearness in mirroring is responsible for our impression that there is chance and in-

determination in the world. Now, in the modern quantum theory, the indetermination which is an essential feature of the world, as represented in the ordinary four dimensions of time and space, is resolved, according to Heisenberg, if a sufficient number of additional, unperceived dimensions are superadded. This is the meaning of the five-dimensional theories of Fock and Klein, and is even more clearly brought out by the study of the problem of many bodies. This problem, which at present possesses no complete solution either from the standpoint of quantum theory or from that of relativity, even in the simple case of two bodies, can only be treated on the supposition that each electron carries with it its own three dimensions of spatiality, or what is more likely, its own complete space-time world. Thus, each electron possesses its own world of dimensions, which mirrors the many-dimensional universe of perfect cause and effect in an imperfect, four-dimensional, non-causal image. It is surely not fanciful to see in this a parallel to the Leibnizian monads, which live out their existences in a self-contained existence in pre-established harmony with the other monads, yet mirror the entire universe.

IT IS not only the antinomy between the discrete and the continuous, between physics and optics, that represents an analogy between Leibniz and the present stage of mathematical physics. His philosophical principle of the identity of indiscernibles is a very live issue at the present moment.

Leibniz asserts that there cannot be two monads in the universe so completely alike that they cannot be discriminated from each other. The modern physicist states that physics has no right to introduce an entity which cannot be, at least theoretically, observed and measured. Thus, Einstein discards the notion of absolute rest or absolute motion, because he can find no conceivable physical experiment to discriminate between the two. Again, Heisenberg will not admit that a particle has simultaneously a well-defined position and a well-defined momentum, because any observation by which the one may be determined destroys the other. In other words, the slogan of modern physics is: back to experiment. Nothing that cannot be observed and discerned has a place in the world of the physicist. By this criterion, indiscernibles may not be recognized as distinct.

Let it be noted, however, that we should now recognize that two electrons which are individually indiscernible may yet by their relations to one another be discriminated as a pair. And here we meet Pauli's exclusion principle, which tells us that while two electrons may be discriminated to be a pair, it is, nevertheless, impossible to say which of the electrons is which. The relation of this to the principle of the identity of indiscernibles is arresting.

The principle of the identity of indiscernibles plays in Leibniz's philosophy the part of a corollary from the more general principle of sufficient reason. For Leibniz, all contingent truths, that is, all truths of particular fact, are determined not merely by the principle of contradiction, but by an additional principle which he calls the principle of sufficient reason, which asserts that some particular perfection must be realized by each phenomenon in this world and by this world as a whole to distinguish it from all other possible worlds. This principle is closely connected with Leibnizian optimism, which became so fashionable in the Eighteenth Century and which Voltaire so mercilessly assails in his "Candide." The reader will remember that Voltaire was not content with a purely impersonal attack on this principle, but supplemented it with a rather bitter personal quarrel with Maupertuis, his fellow scholar-courtier in Berlin. The impression which the wit of Voltaire has left on history is that Maupertuis was an impossible ass and was quite rightly laughed out of the country. This is not fully according to the fact. While Maupertuis was not completely free from the element of charlatanry, he made one very solid contribution (*Continued on page 222*)

Big Eddy on the Columbia River, potential water power site. Parallel to the rapids on the right may be seen the Celilo Canal

Brubaker

GRADUATE ENGINEERING INSTRUCTION

American Engineers Now Take Their Advanced Degrees at Home

By Joseph C. MacKinnon

PRIOR to the beginning of the World War (1914) there was little graduate instruction in engineering or science in the United States. M. I. T. had awarded only 73 masters' degrees and three doctors' degrees in engineering (excluding 50 masters' degrees awarded to graduates of Annapolis). A bachelor's degree was sufficient in engineering, while the students desiring the doctor's degree in science usually studied in Europe.

Since the War, the United States has occupied a more prominent position both in engineering and in science. Our students of science now obtain their advanced degrees at home, while in engineering it has become necessary in most fields to have graduate training in order to advance in the profession. The growth of graduate instruction has been phenomenal, especially in engineering, and Technology has taken a leading part (see chart on next page).

Although the total registration has practically returned to the post-war peak, the proportion of graduate students is distinctly much larger at the present time. This does not imply that Technology is becoming a graduate school, for the freshman class in 1930 was the largest in history, except for the year 1918 when students were admitted without examination to the Student Army Training Corps. Referring to the above chart, it is evident that the number of graduate students increased very rapidly until 1922, remained nearly stationary during the next few years, and then started another increase in 1928. In an article entitled "A Study of Engineering Enrollments" by Walter C. John[1], the total number of graduate students in engineering institutions in the United States in 1930–31 was 2,939. The graduate enrollment of the Institute was 539 or 22.4% (this includes students of science for the Institute and probably for the other institutions).

The important position of Technology in graduate instruction in engineering during the last decade is also shown by a comparison between the graduate degrees awarded by M. I. T. and those awarded by all other institutions in the United States. In Table I, the figures indicate that Technology has been awarding about 30% of the graduate degrees in engineering. These figures include both master's and doctor's degrees.

TABLE I

Percentage of Total Graduate Degrees in Engineering Awarded by M. I. T. 1922–28

(Data from U. S. Bur. Educ. Biennial Surveys)[2]

	1921–22	*1923–24*	*1925–26*	*1927–28*	*Total*
Total in U. S....	394	338	484	580	1,796
No. M. I. T.....	100	112	121	183	516
% M. I. T.....	25.4%	33.1%	25.0%	31.5%	28.7%

[1] The *Journal of Engineering Education*, Vol. XXII, No. 1, Sept. 1931, page 50.

[2] Latest edition "Biennial Survey of Education 1926–1928," U. S. Department of the Interior, Office of Education, Bulletin No. 16, 1930.

The Government Bulletins do not separate the master's and doctor's degrees. The data in Table II from the National Research Council[3] shows, however, that Technology has awarded about 30% of the doctors' degrees in engineering.

TABLE II

Number of Doctorates Awarded in Engineering

	Year										
	'21	*'22*	*'23*	*'24*	*'25*	*'26*	*'27*	*'28*	*'29*	*'30*	*Total*
Total	3	4	5	5	2†	11	10	28	34	49	151
Awarded by M. I. T...	0	2	1	3	4†	4	2	9	4	18	47

† Discrepancy. The S.P.E.E., in reference 4, quotes 8.

It can be assumed from these tables that M. I. T. has also awarded about one-third of the masters' degrees. Technology took the lead in the earlier days in establishing engineering instruction, and it is evident from the figures obtained that it is now taking the lead in graduate instruction and research in the United States. The question naturally arises, is M. I. T. outstanding, or is it only one of several leading institutions? Table III shows the graduate degrees awarded in 1927–28 for the 15 institutions which awarded ten or more degrees.

TABLE III

Institutions Awarding Ten or More Graduate Degrees in Engineering in 1927–28

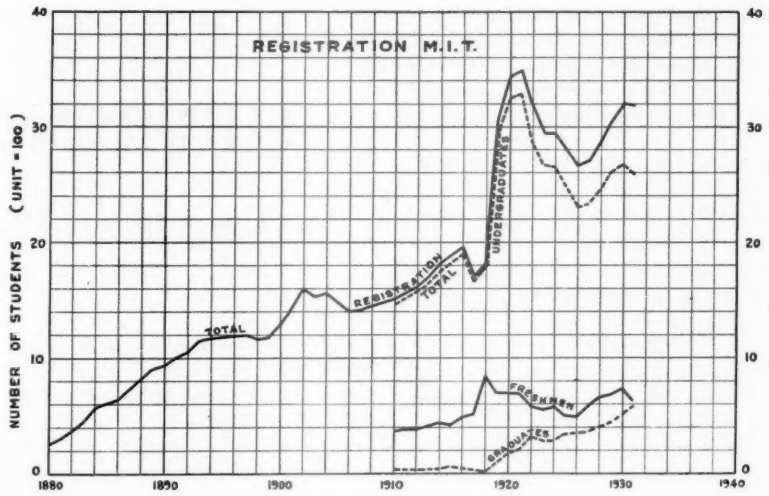
(Source: "Biennial Survey of Education 1926–28," U. S. Dept. of the Interior, Office of Education, Bulletin No. 16, 1930.)

	Total Engineering Registration	*No. of Graduate Degrees*
M. I. T.....	1,965	183
N. Y. University.....	525	38
Harvard University.....	275	37
Purdue University.....	2,236	25
University of Mich.....	1,269	24
Cornell University.....	1,139	21
University of Pa.....	134	15
University of Mo.....	904	14
Col. of City of N. Y.....	218	14
University of Colo.....	681	13
Union College.....	243	11
Yale University.....	625	10
Case School of App. Sci.....	589	10
Penn. State College.....	1,355	10
Mich. State Col. of Agri. and App. Sci.....	572	10
Totals.....	12,730	435

The above tabulation indicates that Technology awarded four times as many as the second institution in rank and more than the next seven institutions com-

[3] "Doctorates Conferred in the Sciences by American Universities 1929–30." Reprint and Circular Series of the National Research Council, No. 95, 1930.

The comparative growth of undergraduate and graduate registration at M. I. T.



M. I. T. has been awarding about 30% of the graduate degrees in engineering

bined. It is desirable, however, to obtain an estimate of the prestige of M. I. T. in the various fields of engineering. This is somewhat difficult due to classification errors in educational statistics, for about one-third of the masters' degrees are awarded without classification as to field. Table IV presents an estimate as to which of the major departments at M. I. T. have contributed most to graduate work in engineering.

TABLE IV

COMPARISON OF GRADUATE WORK IN MAJOR FIELDS OF ENGINEERING AT M. I. T. WITH THE OTHER INSTITUTIONS IN THE UNITED STATES

Engineering Field	*Total Graduate Degrees 1927–28 excluding M. I. T.*	*Graduate Degrees M. I. T. (Average of 5 years (1926–30))*
Aeronautical	7	6.6
Chemical	34	28.6
Civil	75	6.6
Electrical	74	63.4
Mechanical	76	11.4
Mining and Metal.	30	3.2
Totals	296	119.8

It is assumed that the relative distribution of degrees in the major fields in 1927–28 for institutions other than M. I. T. is typical of the distribution for the two years preceding and the two years following. In the case of M. I. T., an average for the five years was taken to even out minor fluctuations. The 88 degrees awarded without specification and the 13 in minor fields are omitted from the United States figures and corresponding omissions are made from the M. I. T. data. This table indicates that M. I. T. has been awarding about one-half the degrees in aeronautical, chemical, and electrical engineering. The proportion pursuing work in most of the major fields would be larger if complete classification in other institutions were available. This is especially true in aeronautical and civil engineering and in mining and metallurgy. Chemical and electrical engineering are obviously the largest departments in graduate work, each awarding about as many degrees as all other institutions combined. Their prominence is not due solely to the coöperative courses in these departments, although they do attract a large number of students.

Graduate instruction in engineering should not be judged by mere numbers. In the Report of the Society for the Promotion of Engineering Education,[4] the following statement is made: "It is also probable that in many instances this fifth year of so-called graduate work is merely an extension of the undergraduate curriculum to cover certain special topics for which there is not sufficient time in the regular four-year course. Real advanced instruction in the fundamentals of engineering is given in only a very few institutions."

Technology from the beginning has stood for a high quality of advanced instruction. The number of graduate students in engineering in the United States has been increasing very rapidly, the increase being 164% in the last five years. It is not hoped or desired that the registration for M. I. T. should increase at this rate. Technology at the present time has only 3% of the undergraduate engineering students in the United States. This percentage is a material decrease from the early position when it was one of the pioneer institutions. Similarly, it is to be expected that, as graduate instruction increases in the United States, the percentage receiving their training at Technology will be much less than the present figure of about 20%. As the present graduate enrollment of about 600 is approaching the limit of our capacity, the scholastic requirements for admission to the graduate school were increased this past fall and the requirements for the master's degree will be increased next June.

[4] Report of the Investigation of Engineering Education 1923–29, page 323.

THE REVOLUTION

Significant Changes that Are and in Business

EDITORIAL NOTE. *Recent fundamental changes which appear to be having a permanent effect upon the business and industrial structure of the future were discussed at a New Year's conference for graduates of the Department of Business and Engineering Administration at the Institute on January 2.*

Significant changes in economic conditions, the marketing of manufactured goods, corporate control, production management, and account control were subjects of papers given by five members of the Faculty. So important does The Review consider this business clinic that a comprehensive summary of the reports is given below.

Interest in the conference, which was arranged by Professor Erwin H. Schell '12, Head of the Department of Business and Engineering Administration, was indicated by the attendance of more than 200 graduates of the Course, many of whom indicated their desire that it become an annual event. The morning session was followed by a luncheon at Walker Memorial, with the program continuing in the afternoon. Following the presentation of each paper there was general discussion of specific problems.

ECONOMIC CONDITIONS

BY DAVIS R. DEWEY

Head of the Department of Economics and Statistics

FROM the host of economic problems which beset us on every side, it is possible to select only a few for special consideration. Of first importance is an understanding of the economic disease from which we are suffering.

First, then, the diagnosis. The central point of economic analysis is price. We live in a competitive economy which expresses itself in some kind of price. There is a price for every commodity — a wholesale price and a retail price; there are prices of raw materials and of finished products. Again, there is the price of labor which we call wages, and this may be priced on the farm, in the factory, the mine, or the office. It may be the price of unskilled labor, or the price of skilled labor. There is the price of governmental services which may be designated as taxes; there is the price of fixed capital invested in business organizations, including railroads, mines, and factories; and the prices of many of these are expressed on the stock exchanges of the country. Again, there is the price of credit, and this also assumes many forms: short-time and long-time credit, domestic credit, and foreign credit.

These prices are in a continual state of flux. Changes in the price of one series offset that of others. And yet, in spite of these rapid and shifting changes, we are able, in ordinary times, to gear these different series together so that our economic machine runs with a fair degree of smoothness, which, on the whole, gives satisfaction. It is not at best a perfect machine; it is constantly in need of repair. But we may well wonder, in view of the multitude of parts which make up this economic machine and the delicate adjustments which have to be made in fitting them together, that the machine works at all.

Now, if for any reason there is a sudden shock, the several parts are thrown out of balance with each other, so that there is maladjustment; the machine breaks down. If prices of commodities, wages, price of credit, taxes, and so forth, previously geared together at certain levels, suddenly shift, some going up, some remaining stationary, and some going down, then exchange from the level of one price series to the level of another price series is interrupted. We have maladjustment; our economic system is out of balance.

New levels must be established and the several parts again adjusted. Certain fields of our economic relationships lack flexibility. In some the adjustments can be quickly made, in others the price adjustments are retarded. Wages do not change as rapidly as prices. The price of long-term credit contracts, previously entered into, is fixed and cannot be changed except by mutual consent or through breaking the contract by bankruptcy. And the price of public services, represented by taxes, is not flexible or easily adjustable.

There is not sufficient space to show in detail how the machine has been thrown out of balance. Prices of commodities in general have fallen 30% in less than three years. The fall in prices of finished goods, however, is not one-half that of the average price decline. Fixed charges have remained almost stationary.

The fall of prices has increased the burden of reparations imposed upon Germany by one-third. Due to this decline in prices England owes the United States as measured in commodities, after paying us hundreds of millions, more than she did when payments began.

Of great significance in this maladjustment is the position of credit. During the past quarter century, the supply of credit has been multiplied many fold. It was enormously increased during the war. Short-time credit oils the gearing of the economic machine so that it runs more smoothly. But in addition there has been a most extraordinary increase in long-time credits. These are contractual obligations which can be met only if the machine continues to run smoothly. If there be a decided fall in commodity prices it may be impossible to meet these obligations.

ON THE RIALTO

Observable in Economic Conditions Technique

In this diagnosis of our economic disturbance it is folly to disregard the parts of the economic machine which are located in foreign countries. These parts are geared into the machine which we are working here at home. Our foreign economic policy may have been a mistake, but we must recognize conditions as we find them. These relationships have been developed through trade, international credits, and commodity prices. Even if our foreign trade is sacrificed through tariff barriers in the interest of home products, we have to reckon with the immense volumes of foreign credits which migrate from one country to another. This migration of capital in turn affects the solvency of banks and the maintenance of gold standards. It is impossible for the United States to free itself — at least in the immediate future — from the repercussions of these changes.

Moreover, the price of many of our domestic commodities is fixed in a world market, and we cannot disregard the forces which are operating in foreign countries, which in turn affect the welfare of our producers.

The third point to be noted relates to the proposals for planning so as to avoid future depression. Planning appears to be an attribute of wisdom and prudence, and is to be commended. But the proposed plans need to be carefully scrutinized. Shall they be carried out by voluntary concerted action or by legal restrictions laid down by the government? If voluntary, can they under our competitive system of individual enterprise be successfully maintained? If governmental, to what degree will there be an encroachment upon personal initiative and individual liberty?

PRODUCTION MANAGEMENT

By Erwin H. Schell

Head of the Department of Business and Engineering Administration

A SIGNIFICANT change in production management is taking place. Its influence is apparent in every aspect of manufacturing operations. It has resulted from the increasing dominance of the market, the continued decline in prices, and the excess of manufacturing facilities. Manufactured goods pass through a series of processes which in the past have been sharply segregated. Purchasing, stores, inspection, fabrication, and assembly — each have represented separate industrial domains. Through these divisions parallel lines of product have proceeded. In other words, the stream of goods in manufacture is divided crosswise by processes and lengthwise by products.

The striking change in production management is the strong swing away from the control of process to the control of product. Today the manager knows the exact status of any one of a variety of lines of output, while yesterday he was better informed of the relative efficiency of each department in his plant.

The stores department used to be termed the "factory bank" and materials were viewed much the same as currency. Now, in some plants we find only a vestige of the original department, while a so-called "program control" routes materials through production sequences in terms of the precise demands of the market.

In purchasing, we find arrangements being effected with vendors so that materials arrive in a thin, swiftly flowing stream, the volume of which fluctuates precisely with the needs of the ultimate consumer.

Even the inspectors who used to be a law unto themselves now find their activities integrated in terms of the product. New forms of incentive payments are linking their interests with those of the productive operators in the attainment of a common goal of quantity and quality and segregated inspection departments are giving way to product scrutiny as it passes along the fabricating line.

In our factory wage systems, the trend toward group bonus has for its purpose the development of product- rather than process-consciousness among employees. Indeed, it is not uncommon to find such bonuses calculated upon the number of finished products rather than upon production at each stage of manufacture.

The fabricating departments were almost the first to show the influence of this new point of view. Straight-line or serialized machine layout was first thought applicable only to concerns enjoying large and uniform product demand. Other plants soon found that surplus equipment might well be used intermittently in such production lines with a desirable economy in set-up as well as direct labor costs.

Above all of these productive functions, we find the new mantle of budgetary control which again lays major emphasis upon product. Indeed, its basis lies in the determination of the volumes of specific products to be manufactured.

Finally, we note the growing tendency in large companies to departmentalize in terms of products and this trend bids fair to continue to the point where each of such divisions will include its own financing and distributing functions.

While numerous obstacles prevent the full development of this trend in many businesses, there is no question that any exceptions to this new rule of industrial conduct must increasingly bear the burden of proof. No manufacturer should longer delay in

applying to his productive organization these test questions: Am I managing my product or my processes? Am I relating my production to consumer demands, or to processing standards? Are my suppliers catering to my orders or my inventories? Are my stores serving as shock-absorbers or as reservoirs? Are my inspectors interested in output of a given quality, or in quality irrespective of output? Are my products in process being routed in terms of operations or in terms of departments? Are my wage systems stressing production or processing? Am I developing productive facilities around my products, or am I adjusting products to my facilities?

DISTRIBUTION

By R. F. Elder
Assistant Professor of Marketing

THE decline in the general price level has led to a shrinkage in dollar volume of sales, even though the physical volume of goods sold remains approximately the same. Since it takes as much space, as much of the sales-person's time, and as much supervision to sell a unit of merchandise as it took before, a higher proportion of the dollar spent in the retail store must go for selling costs until such time as labor, capital, and rental costs can be reduced. Those sellers who have been able to effect economies in their distribution methods are gaining business at the expense of their competitors.

The preliminary statistics of income for 1930 show that individual gross incomes amounted to $21,665,000,000 compared to $28,762,000,000 in 1929. Figures for 1931 will undoubtedly show a still greater fall in this indicator of purchasing power. With consumers determined to maintain their standards of living, the result is that less money is being spent on each commodity rather than that certain goods are being dispensed with. This means a demand for cheaper goods. Because of the large fixed elements of selling cost, merchants and manufacturers are to a very general extent "trading down." The quality of goods is declining more rapidly than prices. The inventory of the average store contains an incredible proportion of junk. The Better Fabrics Testing Bureau of the National Retail Dry Goods Association has stated: "Probably at no time in the last 15 years have standards of quality been so low as in the past two years." This policy of reducing quality in order to sell cheaper is probably being carried to extremes. In catering to people of reduced purchasing power, insufficient attention has been paid to those who have money to buy quality goods. There is ample evidence that this situation has restricted purchasing on the part of those well able to buy.

Buyers are becoming more discriminating. Reduced incomes stiffen their resistance to high-pressure selling. That people will spend their money only for things they need or want is evidenced in the failure of the persistently attempted campaigns to "buy now" for patriotic reasons. Similarly, consumers are losing their faith in certain forms of advertising. It is interesting to note that cigarette sales are falling off despite the reported $47,000,000 advertising appropriations of the Big Four. The old customer loyalties to a store or a brand are giving way to a tendency to compare values. This is a direct result of reduced purchasing power. Consumers may not be any more articulate as to what they *do* want, but they are more keenly conscious of what they *don't* want.

The most significant change in distribution is the greater emphasis which business leaders are putting on the merchandising function, which is essentially finding out what the customer wants and giving it to him. There is an increasing realization that sales strategy alone will not sell goods, and that the product is the vital factor. C. F. Kettering, of General Motors, has advanced the most sensible remedy for the depression yet offered: "In order to sell we must create products that people want more than they want money in the bank." New products, or old products radically improved, are keeping some industries busy and prosperous. Failure to revamp the old product to bring it in line with changing demand is soon reflected in sales figures. Considering automobile registration for the first eight months of 1931, we find that while the entire industry was off 27% from 1930, producers other than Ford lost only 7%, while Ford sales were off 49.5%.

Within the last few months there has become apparent among marketing men a very encouraging attitude. They are realizing that a period of depression is a period of readjustment, of selling methods, of merchandise, and of policies, so that money can be made with things as they are; not as they were last year, or as it is hoped they will be next year. They are beginning to reëxamine the suitability of their products from their customers' viewpoint. They are scrutinizing their marketing expenses and pruning out the extravagances left over from the days of big volume. Incidentally, they are spending more money on accounting for their sales costs, and for maintaining records which give them adequate sales control. And, finally, they are adopting budgetary control of sales and production, based on attainable sales goals, and not on the old policy of "beat yesterday."

ACCOUNTING CONTROL

By Wyman P. Fiske
Assistant Professor of Accounting

FOUR significant trends in accounting control are apparent, each a reflection of a trend in management interest. (1) New devices and methods for bettering control of expenses are being developed. (2) The effects of general economic forces are being segregated. (3) Accounting records are finding increased use as measures of operating results. (4) Accounting analysis is being extended to fields outside factory costs, notably to marketing costs and administrative policy.

There has been a definite shift of emphasis from cost determination to cost reduction. The accountant is recognizing the importance of the Law of Exceptions, which is that "managerial efficiency is greatly increased by concentrating managerial attention solely upon those executive matters which are variations from standards." Variations from scientifically determined standards are being accumulated in the accounting records and included in reports to management. The budget has appeared as a coördinating device and control tool. The budget is a method of combining (*Continued on page 228*)

ATHLETICS AND HEALTH

Do College Sports Injure the Heart?

By Allan W. Rowe

EVEN in sport-loving and sport-practicing America there exists a significant group which opposes all forms of sport on the basis of harmful physical effect. Unhampered by fact and in part, at least, actuated by a well-meaning but ill-advised and ill-directed fanaticism, it leads, from time to time, an attack upon some one sport or a group of sports which for the moment excites its disapproval. Older followers of sport will remember the crusade waged against college football many years ago and Walter Camp's careful study as to the actual underlying facts of the cases cited by the proponents of football abolition. The boy who was reported as killed because of football and who actually was the victim of a street-car accident when returning from a football game in which he had participated was but one of a number of misleading illustrations, put forward, let us hope, in good faith.

Not considering, however, these fanatic outbursts which are engendered solely by prejudice and not by reason, there yet remain questions which must be answered by all of those who are responsible for the welfare of any group in the community. One of the obvious duties which any educational institution must exercise in the care and control of its students is the maintenance of health and physical well-being in the undergraduate group. The responsibility which rests upon the shoulders of the head of the health department of any university is a heavy one, and questions are presented to him daily calling for decision which might affect the health of a considerable portion of his charges. At M. I. T. one such question arose last year as to the possibility of the exercise of rowing producing unfortunate and injurious effects upon the action of the heart. A number of the men in the several crews, all of whom had been carefully examined medically before they were allowed to participate in the sport, developed conditions suggesting lowered or impaired functional activity of the heart. Naturally, they were promptly withdrawn from competitive exercise and as promptly safeguarded from any further injury, if indeed injury had been done, which is very doubtful.

The question, however, is a much larger one than that of the few men who were dropped from the crew and resolves itself into a survey of rowing as a sport and its possible deleterious effects upon an appreciable number of those pursuing it as a recreation. Being personally deeply concerned with the conduct of competitive amateur sport as practiced in our colleges, and directly responsible for certain aspects of it as relating to the student body of the Institute, the writer has considered this question at some length and in some detail. In order to clarify the present situation and establish a sound basis for future conference and consideration, a brief survey has been made of existing literature bearing directly on this topic. This survey embraces a review of over 20 titles, in the main written by men who are recognized as authorities in the field on which they write. Dealing specifically with the sport of rowing, in a few instances, the majority of the papers treat the subject from a broader basis and consider the general influence of various forms of competitive activity upon physical health and well-being. The heart, naturally, is the organ primarily considered, and the papers as selected deal with the question of physical exercise and the heart.

From the material assembled in this article, it would seem to the dispassionate observer that, in the health control of college athletics, it is only necessary to insure the prospective contestant from existing cardiac pathology. The medical examination by a competent practitioner, specially trained in this field and utilizing such additional laboratory procedures as modern science has contributed to modern medicine, should prove a wholly effective insurance against an unwise indulgence. To deny any healthy lad participation in competitive sport, that most normal and wholesome of recreations, would seem to be unwarranted. By safeguarding the unfit, the field is left open to the boy who can derive only health and pleasure from the exercise of his physical powers.

WITHOUT further preamble, a brief review of the several papers noted, may be considered. In 1914, Schumacher and Middleton[1] made an extensive study on the cardiac effects of "immoderate" college athletics. The groups selected were:

a. 20 controls no active sports or training.
b. 3 athletes with "normal" hearts.
c. 10 " , cardiac hypertrophy and slow action.
d. 12 " , cardiac hypertrophy and irritability.
e. 12 " , cardiac hypertrophy, murmur before and after test.
f. 2 " , acute cardiac dilatation.
g. 7 " , older men formerly in competitive sports.

Their conclusions may be summarized thus:

(1) Athletic training leads at first to physiologic hypertrophy of the heart; but when prolonged and marked by severer athletic contests it usually leads to hypertrophy plus dilatation of a variable degree, frequently marked by valvular insufficiency.

(2) Functionally, the hypertrophied heart, even when dilated and giving distinct evidence of valvular insufficiency, may prove more fitted to carry the man through a severe athletic contest than a normal heart would be. On the other hand, acute cardiac dilatation occurs more frequently in athletes and men used to severe muscular strain than in normal men, and the ultimate effects are more prolonged and severe.

(3) There is reason to believe that for normal human activities, an "athletic" heart is distinctly disadvantageous.

During the next year, 1916, a study was published by Lee, Dodd and Young[2] in which groups of oarsmen were the subjects. Avoiding the carefully selected pathological groups of Schumacher and Middleton, in which the ascription of cardiac disease to exercise was in certain measure presumptive, they took three consecutive series chosen solely for their common participation in a single sport. The groups were:

(a) 16 freshmen of athletic type all of whom had been active in physical exercise and a few of whom had rowed previous to entering college.

(b) 16 candidates for crew, all of whom had rowed from two to four years.

(c) 10 graduates, older men with an average record of 10 years rowing experience. All had rowed in at least one four-mile race in college and had been active since graduation.

Careful physical and radiologic measurements demonstrated:

1. No irregularities of heart action.
2. No abnormal blood pressures.
3. No albumin or sugar in the urine.
4. No cardiac enlargement.

In group "A," one subject had a functional murmur; in group "B," there was one systolic murmur, probably functional; and in group "C," two slight functional murmurs were recognized.

They conclude:

The only conclusion that can be drawn at this time from this particular study is that prolonged participation in rowing under the system now in vogue at Havard University and the Union Boat Club of Boston, does not materially increase the size of the heart when the heart is normal at the beginning.

Meylan,[3] quoted by Cole,[4] is the authority for the statement that between the years 1852 to 1892 there was no case of cardiac disease among Harvard oarsmen. That this pleasing state of affairs is not confined to one educational institution is attested by the article of Greenway and Hiscock,[5] quoted editorially in the *Journal* of the American Medical Association[6] in which analysis demonstrated (a) that college graduates live longer than a like group of non-college men and (b) that there was no evidence of injury to the health of Yale athletes as the result of competitive sports.

The first of the conclusions is confirmed by Dublin[7] in an article on the longevity of college athletes. His figures, however, do not implicitly support the second conclusion in its broadest aspect. Designating the expectancy of death as drawn from actuarial tables as the unit, (*i. e.* 100%), he finds the actual percentages, shown on the following page, to derive from a study of 4,976 graduates of ten selected universities all of whom had graduated 33 or more years previously.

Before the age of 45, with the sole exception of crew and baseball, all of the groups show an improved expectancy over the non athletic individual. Inspection of the table demonstrates certain disconcerting inconsistencies such as the fact that participation in two or more sports shows next to the best record before 45 and triumphantly leads the field by a large margin after this chronological Rubicon is passed. Dublin, however, draws the following conclusion:

Of the 315 who died at ages over 45 and whose cause of death we know, 101, or 32%, were ascribed to diseases of the heart. This preponderance of deaths from heart disease is, of course, significant. Among carefully selected insured lives rarely do we find more than 20% of the deaths at the ages over 45 resulting from heart disease.

In other words, the athletes, in spite of their better longevity record than insured men, showed a worse condition as to heart disease. The full importance of this finding is still obscure.

The other important causes of death at the older ages are diseases of the nervous system, Bright's disease, pneumonia, and accidents. The incidence of each of these causes is fairly normal except for accidents, which show a higher mortality ratio.

Taken by and large, it would appear that the group of college athletes studied presented a favorable mortality picture. The experience has been much better among recent graduates than the earlier ones, with the single exception of those who were on the crews."

Sport	*Under 45*	*45 and over*
Football	88.7%	87.9%
Two or more sports	89.7%	71.9%
Track	97.8%	82.9%
Rowing	107.9%	89.2%
Baseball	108.1%	93.9%
All sports combined	96.0%	88.5%

In fairness from the figures cited it would seem as if baseball should be placed in the same category with rowing as it has the worst individual record of all the sports listed. Further, one cannot but wonder how many of the "two or more sport" group rowed or played baseball as one of their activities. The period from which the subjects were selected automatically eliminates many sports that today play an important part in the athletic program and the choice of the two-sport men would be definitely circumscribed.

Dwight,[21] a director of one of the insurance companies, found that cardiovascular disease was much more prevalent among their policy holders in those who followed a sedentary occupation in the city than it was in those whose occupation involved physical exercise in the open air, as farmers. The factor of tension or nervous strain was important in apparently increasing the frequency to cardiovascular disease.

THE question of cardiac hypertrophy has been one of those most thoroughly canvassed. Gordon, Levine, and Wilmaers,[8] studying cardiac size by the x-ray in a group of marathon runners, found no evidence of enlargement and concluded that "many years of the most vigorous physical effort did not produce cardiac hypertrophy." They added the interesting observation that immediately following a race there was a temporary decrease in heart size, with a return to normal during the next 24 hours. This second observation has been recently confirmed by Richards,[9] Buytendijk,[10] and Farrell, Langan, and Gordon.[22]

These last-named authors found, by careful x-ray studies, that in 13 runners, the hearts appeared to be definitely smaller than normal; in five runners the hearts were within normal limits; and in five instances the hearts, according to predicted normal diameters, showed an increase in size. According to the so-called cardiothoracic ratio, only one heart was increased in size. The data as a whole suggest that the immediate effects of long distance running are inconsequential, since all the changes noted may be found in persons of similar age who are without symptoms.

In a series of papers, Herxheimer and his associates [11, 12, 13, 14, 15] report a variety of studies. Examination of groups of boxers, swimmers, runners at all distances, ski runners, and so on [11] leads to the conclusion that the groups indulging in the prolonged exercises have slightly larger hearts than the other athletes or than non-athletic individuals with whom the latter conform. In a later paper [15] he establishes the "heart quotient" as the heart volume divided by the body weight. On this basis, he lists competitors in various sports sequentially in the order of apparent enlargement as follows:

Non-athletic, sprinters, and long-distance swimmers show average figures of 1/62.3 to 1/63.8.

Other records are	
Short-Distance Cyclists / Middle- " Runners	1/55.1
Boxers	1/52.7
Oarsmen	1/51.7
Long-Distance Cyclists	1/48.7
Marathon Runners	1/46.4

The last group, *i.e.*, the Marathon runners, have the largest hearts. The report on boxers is inconsistent with his earlier observations [11] at which time they showed the smallest hearts. In other papers [12, 14] he concludes that in sports which do not require prolonged effort, the body musculature and the heart increase synchronously and proportionately thus maintaining a normal ratio. Where prolonged exertion is necessary (skiing, cycling, rowing, and distance running) the cardiac enlargement outstrips that of the skeletal muscles. There is, however, no dilatation. He believes that this hypertrophy is harmless, being possibly influenced in part by his study of a group of 50 outstanding athletes of older years, all of whom he examined clinically. He and his associates found no evidence in this group of any injury from their earlier exercise and especially none of them showed any arteriosclerosis. They did recognize an apparent slight increase in the width of the aorta, the interpretation of which they regard as unknown.

Dedichen [16] has studied three hundred and sixty-one competitors in a 50-kilometer ski race and found cardiac hypertrophy in 50 (13.8%) as against a similar condition in 12% of a group of 210 dock laborers. He adduces some evidence that the hypertrophy is transitory and that the heart ultimately returns to normal size when competition is discontinued. He finds no evidence that ski running produces immediate or subsequent injury to the heart.

Barringer,[17] in discussing the etiology of heart failure, states:

> The unimportant part which physical or mental strain plays in causing heart failure is shown by the few instances we report, 7 out of 154 patients. It seems improbable that the condition produced by these unusual causes is any different from that existing generally in cardiac failure, for 6 of these patients showed fever and 3 a leucocytosis.

Cole [18] maintains that exercise cannot injure the normal heart but may affect one already diseased. He regards the nervous system (*Continued on page 224*)

THE TREND OF AFFAIRS

IN THIS SECTION: Is the Humidification of Residences Practical and Wise? (212); Self-Unloading Boats and Other Specially Equipped Vessels (214); Glass Insulation (217); Reviews of "A History of Aircraft" and of "Communication," or Engineers Who Can Write (216); Colloid Chemistry (212)

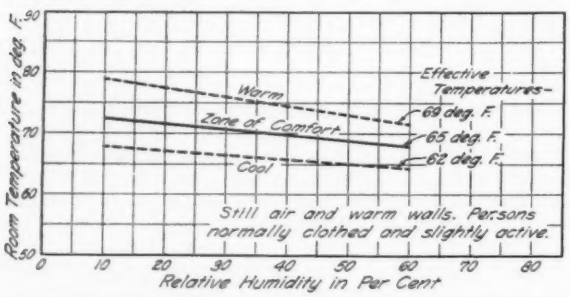
The Glue Family

THE name of colloid this year attains to its three score years and ten, for it was in 1862 that Thomas Graham defined and distinguished colloids and crystalloids. This is young for a name which distinguishes a special branch of science. Dispersoid chemistry is a well-recognized field. The American Chemical Society has a Colloid Division. The Germans have a *Kolloid Zeitschrift*. And the name means only gelatinoid, or glue-like.

While the name is young, the colloids themselves are an ancient race, the most ancient of all races, as old as life — for all living matter is colloidal. Before ever life was, there were colloids, and the colloids conspired with one another and there was protoplasm.

Graham observed that salt and many other crystalline substances, if dissolved in water, diffused through a parchment membrane, while glue, under like conditions, diffused but little or not at all — and gave the name of colloid, from the Greek word for glue, to substances which possess this latter character. Solutions of colloidal substances may be filtered through the usual filtering mediums without change. They appear clear in ordinary light, but are opalescent under intense illumination. They consist of exceedingly small particles of the colloidal material, particles, however, which are vastly larger than molecules but are yet so small that they do not settle out of the solution. The natural motion of the molecules of the solvent keeps the larger colloidal particles in suspension and in constant movement. The movement may be seen if a narrow and powerful beam of light is passed into a drop of the solution under a microscope. The Brownian movement may be seen in the ultramicroscope — for the particles, too small really to be seen, are yet large enough to reflect some light, and twinkle in the powerful illumination like little stars.

Colloidal solutions of the metals may be prepared in a variety of colors, either by treating a solution of some salt of the metal with a reducing agent, or by passing an electric arc between pieces of the metal under water or another solvent. If the colloidal particles are small, the solution appears blue by reflected light, for the small particles are large enough to reflect the blue light of short wave lengths but not large enough to reflect the longer wave lengths of the red end of the spectrum. They allow these to pass, and the solution by transmitted light appears reddish brown. A colloidal solution which exhibits these properties may be secured by adding a little milk to a glass of water. In that case the colloidal particles are ultramicroscopic globules of butter fat.



Comfort chart developed by the Research Laboratory of the American Society of Heating and Ventilating Engineers. *See page 214*

Solutions of colloidal silver, argyrol, collargol, and so on, find wide use in medicine as antiseptics for infected mucous surfaces. Their action is not well understood. When it is, there will be an important scientific discovery, for they kill the germs in or on the body but are without effect on the same germs growing in cultures in glass vessels.

The ancient Babylonians knew how to manufacture glass which was colored red with colloidal gold, but the art was lost and the other nations of antiquity produced red glass, or glaze, by a different principle by the use of compounds of copper or of iron. In the Seventeenth Century a German, Dr. Cassius, prepared a purple pigment by adding stannous chloride to a solution of gold chloride. His purple was hydrated stannic oxide colored with colloidal gold. Johann Kunckel von Löwenstern soon found a way to prepare ruby glass from the purple of Cassius. Several pieces which he made for the king of Saxony are still preserved in the Museum at Dresden. The red glass which is now so extensively used for railway and traffic signals and for photographic purposes is colored with colloidal selenium.

Humidification for Residences

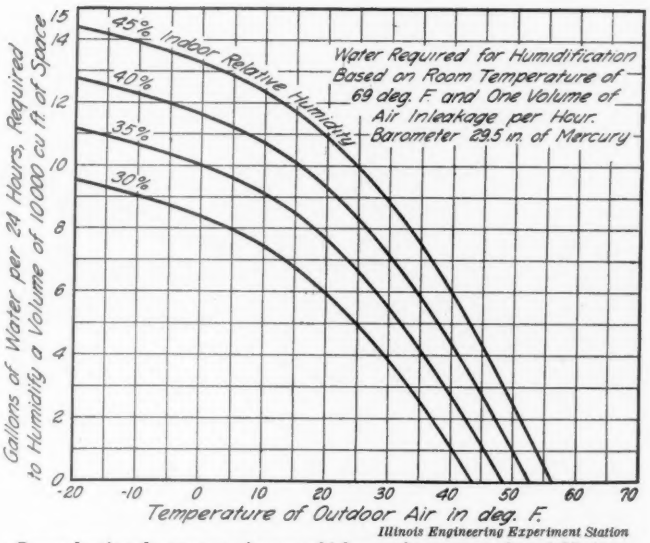
WE HEAR on every side that we are entering an age of air-conditioning, an era of manufactured weather. The air-conditioning engineer has even been heralded by professional optimists as the Moses who will lead us out of the depression by the simple achievement of making the control of indoor weather so practicable, cheap, and appealing that the moribund buying public will be revived and will demand that the trains and ships it patronizes, the place it works in, and its home be air-conditioned.

If there be an excess of optimism in this roseate view, the fact remains that there are many signs and portents to support the forecast. For a number of years, groups of engineers have been converging on the problem of making air-conditioning commercially practical for small interiors. Some one with a penchant for statistics

has counted 70 companies engaged in research for providing improved air-conditioning equipment, particularly for offices and residences.

Some of these companies champion complete systems that will cool and dehumidify indoor air in the summer and heat and humidify it in the winter. Others are manufacturing single room units, either for summer cooling or winter humidification. Since winter comfort is a very present problem, we shall confine this discussion to winter conditioning in the anticipation of examining at a more seasonable time the art of keeping cool.

Heated air has a great capacity for absorbing moisture. In other words, the capacity of air for holding moisture increases with its temperature. For example, the air required to fill a space of approximately 15,000 cubic feet at zero degrees Fahrenheit can hold but one pint of water, whereas at 70°, it can hold two gallons, or 16 times as much. This means that, when air is heated, it tends to absorb moisture, and this accounts for its drying effect.


Gallons of Water per 24 Hours, Required to Humidify a Volume of 10000 cu ft. of Space
45% Indoor Relative Humidity
40%
35%
30%
Water Required for Humidification Based on Room Temperature of 69 deg. F. and One Volume of Air Inleakage per Hour. Barometer 29.5 in. of Mercury
0 2 4 6 8 10 12 14 15
-20 -10 0 10 20 30 40 50 60 70
Temperature of Outdoor Air in deg. F.

Illinois Engineering Experiment Station

Curve showing the amount of water which must be evaporated to yield given relative humidities under various conditions

It is the purpose of winter conditioning, or humidification, to supply the heated air in our buildings with the proper moisture, which, it has been generally agreed, is in the vicinity of 40% relative humidity.

When the weather is cold, this is obviously difficult to do, so thirsty is the air, not to mention the walls and furnishings, and so great is the air leakage of buildings, particularly residences. When the temperature is in the vicinity of zero degrees Fahrenheit on the outside, the maintenance of a 40% relative humidity under certain conditions requires the evaporation of one gallon of water per hour. This means, of course, that water pans on tops of radiators would not be adequate, nor would the water pans in hot air furnaces.

The curves shown at the top of this page give an approximate reading of the amount of water it is necessary to evaporate at various outside temperatures in order to obtain humidities of from 30% to 45%. Those who are contemplating installing humidifying devices in their homes will realize from these curves that the equipment must evaporate surprisingly large quantities of water in cold weather.

There are, of course, a number of humidifiers of adequate capacity to evaporate ample water. Some are simply small editions of the spray "heads" which are used in industrial plants. By means of pressure or electric fans, these project water to the air in the form of a very fine spray. They are usually noisy, particularly those with fans; and because they spray instead of evaporate, there is danger of wetting adjacent objects. One company has recently designed for residences an evaporation radiator, which evaporates water by heating it with the steam from the heating system. Since this humidifier has no moving parts, is perfectly quiet, and is also subject to automatic regulation, it possesses many advantages over the fan or spray devices. To be sure, it requires permanent connections with the heating and water supply systems. Still another company is actively advertising equipment to be appended to hot air furnaces, the price of which is of the order of $200.

The criteria for all of these systems are: their evaporative capacity, their economy, their quietness, and their sensitivity to regulation; that is, these are the criteria if one accepts the hypothesis that it is wise and feasible to humidify a residence. Many investigators contend that it is not necessary and expedient to do this; one group claiming that houses are not adequately constructed to make humidification practical and that if they were, air-conditioning would be almost unnecessary; another contending that the humidity may be sufficiently controlled, so far as health is concerned, by varying the dry-bulk temperature; and still another maintaining that humidification is economically impractical, the mechanization of the home having already been carried to the extreme. There is ponderable evidence behind these left-wing views that should be carefully considered by prospective purchasers of humidification equipment. No one questions, however, the value of humidification to prevent deterioration of furniture, wallpaper, hangings, and rugs as a result of excessively dry air.

Before accepting the ballyhoo of the advertising pages, the home owner might also wisely familiarize himself with the theory behind air-conditioning. He will find that it is predicated on two separate needs, comfort and health, and that these two do not always coincide. Optimum comfort at any season depends not so much upon ordinary dry-bulb temperature, but upon the degree of ease with which the human body can accomplish its heat regulation. This regulation depends not only upon temperature, but on humidity and air motion as well. In other words, the elimination of heat from the body surface depends upon convection, radiation, and evaporation. One investigator (Aldrich) has concluded that at normal, indoor temperature, in still air, the clothed body at rest dissipates heat approximately as follows:

Convection	30%
Radiation	46%
Evaporation	24%

Rock Products

Typical view of self-loading boat discharging cargo at dock

Unfortunately there is no instrument (except the severely limited Katathermometer) which will take into account all of these factors; that is, measure the degree of comfort. The Research Laboratory of the American Society of Heating and Ventilating Engineers, however, has determined empirically a condition of maximum comfort which it expresses in terms of *effective temperature*. Combinations of dry-bulb temperature and relative humidity affording the same degree of comfort are said to produce the same *effective temperature*. The condition of maximum comfort seems to be in the vicinity of 65° F. Eff. T., a condition obtainable with various dry-bulb temperatures by varying the relative humidity. See the comfort chart on page 212.

There are objectors, as might be expected, to this philosophy of comfort evolved by the heating and ventilating engineers. The New York Commission on Ventilation, in its final report recently issued, states that "we of this Commission are not all in accord as to the theoretical soundness of the 'effective temperature' concept. . . . The effective temperature index has, however, made it possible to determine and to express in a single factor the usual minor variations from any established optimum conditions for comfort."

Health and not optimum comfort was the basis of the New York Commission's study, which, of course, was concerned with school ventilation. We find, therefore, in the conclusions of this report the opinion that "the major objective of schoolroom ventilation is the provision of such atmospheric conditions as will facilitate the elimination of heat from the body surface without the production of objectionable drafts. In practice, this means the maintenance of a room temperature of 68° to 70° F. with moderate air movement. *Under such conditions, special control of humidity is not essential, except perhaps in certain northern regions where humidity is exceedingly low in cold weather.*" [Italics ours.]

These findings about schoolroom conditions may, in the main, be applied to residences with the resultant conclusion that if health is the criterion, humidification is not generally required. Even from the standpoint of comfort, we find the Commission expressing the opinion "that moderate variations in relative humidity do not affect the sensation of comfort at ordinary temperatures. In the schoolroom the ordinary thermometer is our best guide."

The propaganda now being broadcasted to prove that the incidence of respiratory disease in the winter derives from the low humidity conditions in our homes and buildings is an unwarrantable assumption. It is just as reasonable to conclude that the increase is the result of a decrease in the sale of Palm Beach suits.

Prospective buyers of humidification equipment should read the final report of the New York Commission, entitled "School Ventilation, Principles and Practices," and in addition "Humidification for Residences," by Alonzo T. Kratz (Bulletin No. 230 of the Engineering Experiment Station of the University of Illinois). The latter report, among its other conclusions, says:

"Relative humidity of 40% indoors cannot be maintained in rigorous climates without excessive condensation on the windows, unless tight-fitting storm sashes or the equivalent are installed.

"The problems of humidity requirements and limitations cannot be separated from considerations of good building construction. . . . If these factors are not considered, and the purchase of humidification apparatus made solely on the basis of expected evaporative performance, the result is liable to end in disappointment."

Specialty Craft

RUSSELL OWEN'S news dispatches from the Antarctic indicating that the Byrd Expedition would, if necessary, look to Norwegian whalers for rescue, brought descriptions of these peculiar and seldom heard of vessels to the front pages of the New York *Times* and other dailies two winters ago. The largest of these floating whale factories, the S. S. *Kosmos*, it transpired, had a gross tonnage over half that of the *Mauretania*, while in length she was a duplicate of the *Malolo*, which at the time was the fastest liner in service on the Pacific. In operation, the *Kosmos* acted as a mother-ship for an airplane, used to spy out whales, and for seven small, steam-operated "catcher" boats, while her electrically operated refinery and compressor was in constant readiness to "blubber" a catch within 15 minutes after it hit the deck.

Besides the whale factories, floating canneries are used to some extent in the crab and salmon fisheries of North Pacific waters. However, these are not the sole

industries for which particularly designed ships have been built. Specialized carriers have been constructed for many cargoes having the fairly common fundamental purpose of lessening transportation costs through hastening the loading and discharging processes. In addition to keeping a ship on the move, they shorten the time taken for "turn rounds" and thus lower port and labor charges.

Perhaps the earliest example of a steamer built for a specific purpose is afforded by the 417-ton *Leviathan*, which the North British Railway put in service in 1849 to transport trains across the Firth of Forth. Since then many car ferries have been built for inland waters, the largest on record being the *Contra Costa* of 1914, a wooden vessel of 4,483 gross tons, employed by the Southern Pacific to carry trains across Carquinez Straits in California before the Martinez-Benicia bridge was completed in 1930. Other important examples of interesting design are the screw ferries *Dolores de Urquiza* and *Schwerin*. The former carries trains of the *Entre Rios* Railways about 50 miles on the Parana River in the Argentine, while the latter is operated by the *Deutsches Reichsbahn* across an arm of the Baltic between Warnemüde, Germany, and Gjedser, Denmark. The *Schwerin* is equipped to burn oil or coal, and can carry 18 freight cars, or seven passenger coaches, and 800 persons.

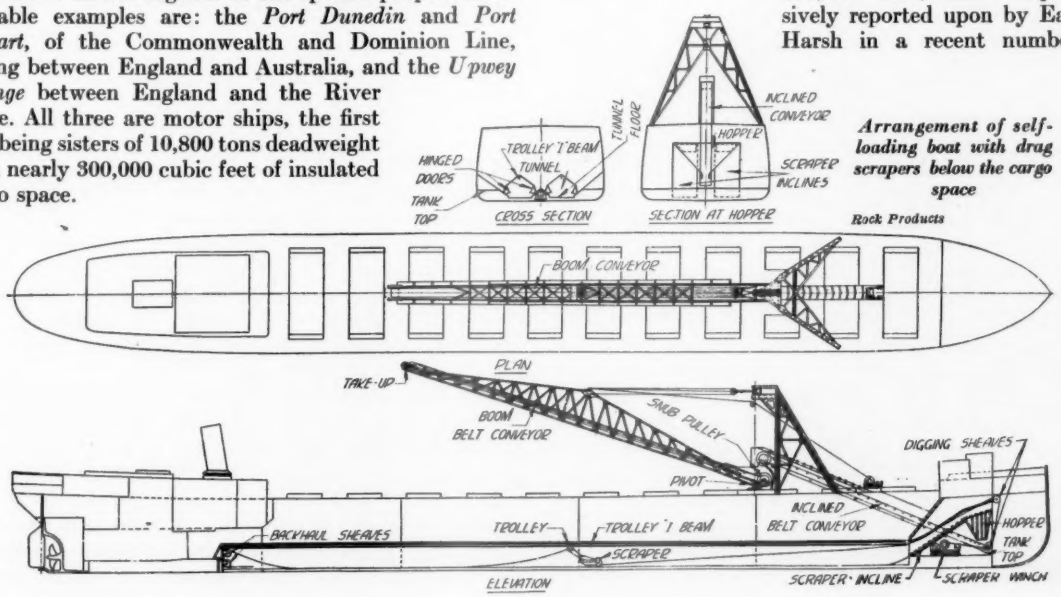
About three years ago Over-Seas Railways put in service between New Orleans and Havana, the S. S. *Seatrain*, a train ferry of a new type which utilizes more completely the ship's cargo capacity. Instead of cars being rolled straight on rails on the deck of the *Seatrain*, they are lifted from the pier by means of a 150-ton crane and a cradle which is fitted with tracks. After being lowered through a hatchway, a car is removed from the cradle and stowed upon a track in the hold by a mechanical car puller. This *Seatrain* can carry 95 cars of average size on her three decks.

Meat-carrying ships with refrigerated holds are also prominent on the register of the specific-purpose fleet. Notable examples are: the *Port Dunedin* and *Port Hobart*, of the Commonwealth and Dominion Line, plying between England and Australia, and the *Upwey Grange* between England and the River Plate. All three are motor ships, the first two being sisters of 10,800 tons deadweight with nearly 300,000 cubic feet of insulated cargo space.

Assembled automobiles, locomotives, and other railway rolling stock, as well as other heavy, uncrated, export shipments go overseas in bottoms particularly arranged for such purposes. The S. S. *Tractor*, now over six years old, is one of three ships ranging in capacity from 200 to 600 set-up autos, operated by the Arnold Bernstein Steamship Company. Loading is accomplished over a movable gangway, the automobiles passing through side ports on their own wheels, then to be lowered into the holds by means of interior elevators. The *Belpariel* is one of eight ships of the Christen Smith Company, equipped to handle entire locomotives, tenders, and passenger or freight cars. On one voyage from the United States to Brazil she carried: two 60-foot mail cars and two 60-foot baggage cars in her afterhold; thirteen 70-foot coaches, three 72-foot parlor cars, and two 83-foot diners over the hatches thwartships; and the trucks of these 22 all-steel cars in her forward hold.

However, it is in vessels fitted primarily for handling bulk cargo, such as oil, crushed stone, gravel, sand, coal, and cement, that naval architects have rendered the most numerous examples of specialized tonnage. Tankers to carry crude petroleum and its various products have been known ever since the *Gluckauf* of 1886, although the amazing fecundity in tanker building began with the War and the increased use of liquid fuel afloat. World tanker tonnage, which in 1914 was less than one and a half millions, rose to five millions by 1922 and is now over eight and a half millions, or about an eighth of all tonnage in use. Besides petroleum carriers, there are now tankers for molasses and vegetable oils.

On the Great Lakes, bulk freighters have reached a high development. They vary from the one extreme of the whale-backed tanker or grain carrier, where loading and unloading equipment is customarily absent so far as the ship is concerned, to "self-unloaders," which can discharge their cargoes entirely independent of any or all shore plant. The latter vessels, of which there are upwards of 70 with a total cargo capacity of more than 280,000 tons, are comprehensively reported upon by Earl C. Harsh in a recent number of



Arrangement of self-loading boat with drag scrapers below the cargo space

Rock Products

Charles G. Abbot, '94, Secretary of the Smithsonian Institute, and the harmonic analyzer he has developed for discovering and evaluating periodicities in solar variation. It is to be used in long range weather forecasting and is another example of the machines that are being developed to do the menial work of thinking *(see The Review for January, page 171)*

Rock Products. As he points out, they probably account for the fact that shipments of crushed stone on the Great Lakes increased over five-fold between 1914 and 1929.

Early self-unloaders, such as the *Hennepin* of 1902 and the *Topeka* of 1905, used a system of belt conveyors below the cargo space. These discharged the material to an inclined conveyor and thence to another belt conveyor mounted on a boom swung out over the dock. The most recent boat of this type is the *J. R. Sensibar*, 556 feet long, with a cargo capacity of 10,000 tons, which it can unload within five hours. To increase the unloading radius of the boom, some ships have installed an auxiliary "thrower" at the end of the boom conveyor. One such device, the Stephens-Adamson, heavy-duty, box car unloader throws the material 30 or 35 feet.

With the patenting of the tunnel-scraper system by Leathem D. Smith in 1923, self-unloaders were judged feasible for ocean use. Under Mr. Smith's patent two or more longitudinal tunnels are built in at the bottom of the ship's hold. They are hoppered so as to be self-cleaning and have hinged doors on either side to permit the cargo to slide into them. In each tunnel a crescent-shaped drag-scoop, pulled by a system of cables, hauls the material to a hopper which feeds into an inclined conveyor and boom belt conveyor such as described in the preceding paragraph. The latest addition to vessels of this type is the *H. F. De Bardeleben*, used in ocean commerce on the Gulf of Mexico as a coal carrier.

The above types of self-unloaders are adaptable for crushed stone, gravel, coal, or sand, though a type with suction pumps and pipe lines instead of conveyors is often used for sand. Bulk cement is handled in the most up-to-date way in ships which feed, either by the tunnel-scraper system or by means of screw conveyors below the cargo, to Fuller-Kinyon pumps which force the material ashore through pipes or to a bucket elevator and then to a screw conveyor which carries it ashore.

Engineers Who Can Write

FOR those who would understand the significance of science and technology and their place in society, there is probably no better approach than the historical. The two books commented upon below, one a history of aviation, the other of communication, serve as admirable examples of history as a path to appreciation and understanding. Both of them are written by men trained as engineers and they are, therefore, technically sound. Moreover, by being well written, they demonstrate that the technician can be articulate, although deplorably few of them are.

SCION OF "SKYHIGH"

A HISTORY OF AIRCRAFT, by F. Alexander Magoun, '18, S.B., S.M., and Eric Hodgins, '22, S.B. $5.00. xx+495 pages. New York: *Whittlesey House, McGraw-Hill Book Company.*

The great bulk of this book, due to its organization and thoroughness, should really serve for all time as the backbone for aeronautical history down to 1914. Especially noteworthy are the treatments of helicopters, ornithopters, and parachutes, types of aircraft which have never before been systematically traced through their developments. Balloons, airships, and planes are also handled with what is certainly wider coverage than any preceding work. It is only fair to previous authors of real ability, however, to point out the tremendous advantage Magoun and Hodgins have had in the shape of such material as the Smithsonian bibliography, the general literary product of the last ten years' intense interest in aeronautics, and from collections of *aeronautica* not previously available.

The first chapter might have been omitted, or else done much more completely. It is the only part of the book, except the preface, where the burden of the narrative is shifted from the interest of the historical matter to the literary style of the authors. Of the judgment displayed in weighing the probability of events and the merits of the competitors in such controversial matters as cannot be avoided in any complete historical work, one finds little to take exception to save, possibly, the general handling of the Wright-Langley-Curtiss controversy. The present work is what might be described as not pro-Wright, to which stand the authors are undoubtedly entitled, although their grounds for arriving at it might well be debated.

One weakness of the book lies in the treatment of the last 15 years. Even in some of the best chapters (let us say parachutes, helicopters, and gliders) as it crosses the 1914 line, the narrative dwindles from beautiful completeness to a few weak high spots, a footnote or two, or perhaps an account with important omissions. The same period, generally treated, takes the form of a rather over-Fokkerized chapter on the War, which is

not up to the rest of the book, and a summary record of all the recent stunt flights down to Post and Gatty, with some exceptions. As long as the attempt was frankly being made to carry their completeness to the present year, it is unfortunate that there is nothing on the post-war development of commercial aviation or on post-war design. Suggested chapters for the second edition would include some account of the development of altitude flying, speed racing (such as the contests for the Schneider Cup), and other features of airplane performance besides sporadic cross-country flying.

Despite these minor lacunæ, the book and the work which has gone into it undoubtedly must be ranked with the previous efforts in England of Cavallo ("History and Practice of Aerostation," London, 1785), Vivian and Lockwood Marsh ("History of Aeronautics," New York, 1921), and Hodgson ("History of Aeronautics in Great Britain"), and in this country of Chanute ("Progress in Flying Machines," New York, 1909), and Zahm ("Aerial Navigation," New York, 1911). The large number of general volumes in this field which have been published in the past five years have contributed little in new matter, thoroughness of scholarship, or quality of treatment. Most of them are rehashes of the aforementioned classics. It is refreshing that Magoun and Hodgins have given us something scholarly and valuable.

DANIEL C. SAYRE

A HISTORY OF MESSAGE-SENDING

COMMUNICATION, by David O. Woodbury, '21. $2.50. 280 pages. New York: *Dodd, Mead and Company.*

If a person talks by telephone from Chicago to New York, his voice must be amplified a hundred billion billion billion billion billion times (10^{47}) as it travels the 800-mile course. If he talks from San Francisco to Europe, the required amplification is so preposterously great that it is necessary to combine astronomy and atomic physics to find a measure of the magnitude.

To use a current analogy, the process of transmission from the west coast to Europe requires an amplification of the energy of the voice by a factor larger than that by which the known universe exceeds in size the tinest known object, the electron. These are appalling figures, but they suggest a measure for man's advances in communication technique.

It is this story of achievement that Mr. Woodbury relates, and in a manner enabling all to understand. In a rapid and readable style, he has traced the history of communication "from a simple interchange of signs or sounds between individuals face to face to a vast and complicated network of channels, through which the messages of whole nations pass to every corner of the earth with the speed of light."

Of course, the real advance in communication technique came with the application of electricity, and the invention and development of telegraphy, telephony, and wireless occupy the major portion of the book. Other chapters, such as "The Story of the Mails," "Special Applications of Communication," "Images Through Space," "Communications in the World War," serve to round out the history of message-sending.

Mr. Woodbury achieves the difficult feat of popularizing without vulgarizing. In such a book attenuation is unavoidable; it is impossible to present more than the high lights, and vast amounts of material must be left untouched. The only really disappointing omission was the lack of credit to Oliver Heaviside for his fundamental contributions to telephony. Pupin, his debtor, is mentioned at length, but the more colorful, interesting, and brilliant Heaviside is mentioned only because he gave his name to the Heaviside layer.

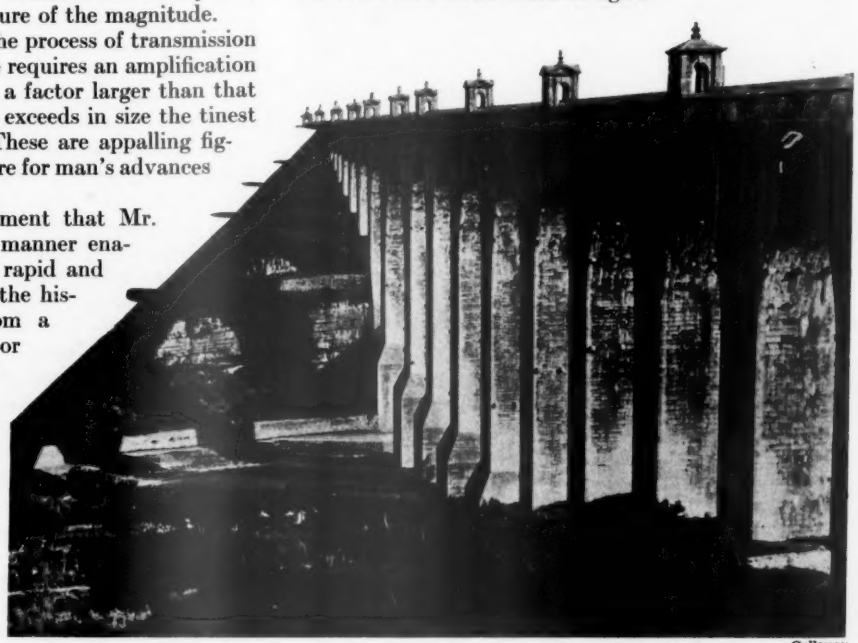
J. R. K., JR.

Vacuum Glass Insulation

LAST July The Review described glass bricks and their use in building construction and mentioned at the same time a glass block with a hollow interior from which the air is exhausted.

These vacuum glass blocks can be used most profitably for window openings, skylights, and as a lining for masonry. Tests have indicated that heat losses through vacuum glass in British Thermal Units per degree difference in temperature per hour may be less than the heat loss through a 40″ concrete wall and less than the heat loss through two inches of cork.

In addition to the high insulating qualities of these blocks, they also possess great powers to arrest sound. Hollow building blocks of Pyrex glass are also available in America. These blocks have surface patterns designed for controlled distribution of light.



The aqueduct of Aguas Livres supplies Lisbon, Portugal, with water. It was constructed in the early Eighteenth Century

Galloway

TRANSATLANTIC

The Shattered Nerves of Europe

AFTER my somewhat scanty budget of last month, I now find myself so overburdened by a wealth of impressions that I must needs exceed the 750 words of my normal allotment. As to the physical facts of my trip: we left Cambridge on the fifth of December for the Continent, by way of Harwich and Hoek van Holland. From there I called up Schouten at Delft. He asked about his friends at M. I. T. and exacted a promise that I should call at Delft on a later visit. We proceeded to Hamburg, where we were treated with great hospitality by Blaschke and Artin. I hoped to be able to run up to Kiel to visit Robert Schmidt, but time was too short, and Schmidt looked us up in Hamburg instead. On the ninth, I lectured to the Mathematical Club on Tauberian Theorems. Hecke was present — also a young assistant Petersen, who seems to have a very promising future — and they took part in the discussion. The next day we went on to Berlin, where I parted from the rest of the family, proceeding to Vienna via Prague, while they continued to Breslau. Menger met me early on the morning of the eleventh, and after resting, I gave another lecture, this time on Harmonic Analysis. Professor Hahn was present and took part in the discussion. Afterwards we had a *Nachsitzung* at a nearby café, where I met the Vienna mathematicians, besides Frank of Prague (German university) and Miss Wrinch of Oxford. I had the pleasure of sitting beside Professor Tauber, after whom Tauberian theorems are named. The next day I met Professor Wirtinger, who asked after many American friends. I am at present still in Vienna, enjoying Menger's hospitality, and Wednesday I am to say something about capacity and its axioms to the young students of his colloquium.

Now as to my impressions: first, as to the general situation in Germany and Austria. Naturally, they can only be superficial, and are rather an account of the reaction of the people I have met than of the actual situation, whatever that may be. The reaction is one of depression, of hopelessness, almost of resignation. Everyone awaits a crash, no one knows from what direction it will come, and no one of my friends has the least expectation that any *coup d'état*, whether from the right or from the left, will appreciably better matters. I have not been able to discern much enthusiasm for Bolshevism, but what is growing on all sides, with few exceptions, is a consciousness that the present economic order has played itself out. Perhaps the best expression of this point of view was made to me by Haldane at Cambridge. He said that if anyone could persuade him that the equations governing the capitalistic system had a stable solution, containing no exponentials in the time with exponents with positive real part, he would vote conservative from then on, but that since he was convinced that there is nothing to prevent economic cycles from becoming progressively more extreme, he was forced to be a socialist. In any case, there is a widespread feeling that only in a world-wide, planned, economic system can there be any security, and that the era of free competition is dead, and only awaits a decent funeral.

The misery among the German lower classes is intense, and the situation threatens to become as bad in Austria. As to the intellectuals, the strain of a continually uncertain future is telling hard on them. It is impossible to have peace of mind in the Germany of today — perhaps I should say in the world of today, although the older English universities furnish a fair approximation. In Germany there is a continual suppression of assistantships, cutting of salaries, and no man knows one day what is in store for him on the next. What is even worse than personal discomfort and suffering is the uncertainty of the whole order of things, so that no one is sure whether the whole European culture of which he is a part and for which he is working may not be crossed out with a few strokes of a dictator's pen, or effaced by the bloodshed of a revolution.

The situation is so bad that it has gone far beyond the stage of resentment and hatred. The German intellectual has almost come to accept the intransigence of France as an objective fact, ruinous to Germany, but to be accepted without much emotional reaction, because France is only one step behind Germany on the way to economic ruin, and it is a case of *sauve qui peut*. If by some miracle it should become possible to restore economic and social prosperity to the world, it would still be a matter of 20 or 30 years to restore confidence and peace to the shattered nerves of Europe.

To come to purely scientific matters: if I have found the English too inclined (for my taste) to champion the cause of the individual problem, and to regard mathematics as a collection of puzzles, I must also admit that the German taste for programs and schools goes further than I should care to follow it. The Vienna school has done wonders in the direction of the theory of dimension and of abstract logic, but to my notion they are a little over-sanguine as to the power of postulational methods. It is, of course, true that every mathematical system may be deduced from a set of first principles, but in the practice of the axiomatists, these first principles tend to take on a severely schematized and formalized shape. To demand that every mathematical system should be deducible from a set of postulates of predetermined type would be much like demanding that every function should satisfy an algebraic differential equation of finite order — which we know to be false. An instance in point is that of electro-static capacity. Menger's first reaction was that this point-set function could be axiomatized in a fashion similar to that in which he had already treated measure and (*Concluded on page 220*)

THE INSTITUTE GAZETTE

A Portrait of Major Briggs

A PORTRAIT of the late Major Frank Harrison Briggs, '81, for years a leader in the development of athletics at Technology, was exhibited for the first time at a private showing in the Office of the Dean on January 8.

The portrait, done in oils, is the work of Emil Pollak-Ottendorff, Boston artist, who painted the well-known portrait of the late Dean Talbot. It has been presented to the Institute by the Alumni Advisory Council on Athletics, which was founded by Major Briggs in 1898, 17 years after his graduation from the Institute. Major Briggs was the first chairman of the Advisory Council on Athletics, and later was its treasurer. From his early days at the Institute until his death on April 8 of last year, Major Briggs' interest in college athletics was unflagging, and the significance of his influence upon sports is well indicated by the inscription on the portrait. It reads:

"By precept and example, he inculcated, developed, and exemplified those high ideals of true sportsmanship which are the sound basis of human relations; with far-seeing vision, he conceived and advocated those principles of conduct which today are developing and moulding the youth of this country."

Major Briggs came from an old New England family, famous on Cape Cod as builders of ships in the days when Massachusetts sent sailing vessels to every port in the world. He himself became a leather merchant, and at his death was the sole remaining member of an old Boston firm.

In 1897 when Major Briggs undertook the establishment of the Advisory Council on Athletics, sports at Technology were being carried on independently by undergraduate captains and managers. Financing athletics under this procedure was difficult, and various teams were in debt for equipment and trophies. It was then that Major Briggs, moving spirit of a small group of Alumni, proposed the Advisory Council on Athletics to aid the students in solving some of their problems. It is interesting to note that the policies laid down then by him are those which, with but slight modification, are the basis of the guiding principles of athletics at Technology today.

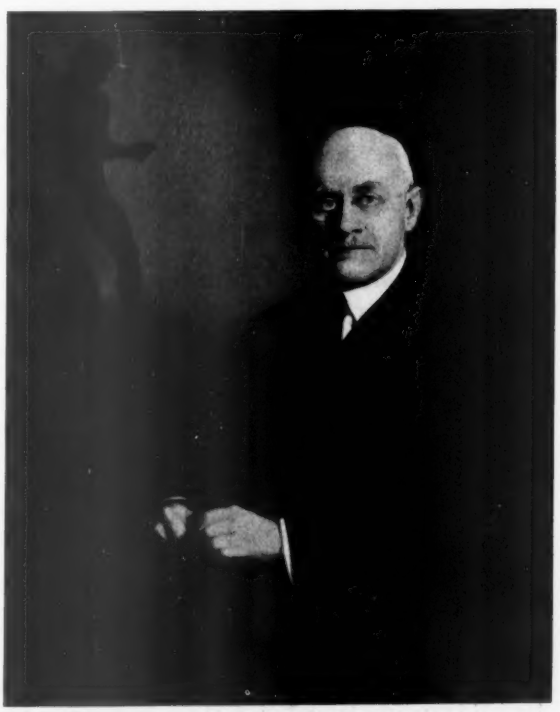
It was Major Briggs' vision which anticipated and advocated such advances as the freshman rule, intramural competition, and many other practices which are commonplaces of college athletics of the present, years before they were recognized and accepted by the college world at large. It has been said of Major Briggs that he more than any other single individual was responsible for the standardization and rationalization of college athletics.

Among those who came to the showing of Major Briggs' portrait were members of the Faculty and Corporation of the Institute, the Advisory Council on Athletics, sports writers, and present and former college athletes.

A Service for Electrical Engineering Alumni

WHILE the Institute does not formally operate any university extension or alumni education program, it has various components following a procedure which virtually amounts to such a program. The Technology Review, for instance, makes available to Alumni information about scientific work at the Institute and elsewhere. The Seminars held in New York and Pittsburgh in coöperation with the various courses of the Institute constitute another method for keeping Alumni informed. A third method has been admirably used by the Department of Electrical Engineering.

This Department keeps in close contact with its graduates and sends out from time to time bulletins which might be of assistance to them in their work. Material which has been sent out heretofore consists of a pamphlet entitled "Bibliography of Bibliographies in Electrical Engineering, 1918–29"; Department Bulletins No. 74 and No. 75; a Log-Log Vector Slide Rule chart, prepared by Professor Carlton E. Tucker, '18, for use in connection with the Puchstein-Wein-



A portrait of the late Major Frank Harrison Briggs, '81, executed by Emil Pollak-Ottendorff

bach Slide Rule; Complex Hyperbolic Function Charts prepared by Professor Louis F. Woodruff, 2d, '18, covering the power transmission range; and Vail Library Bulletins.

This undertaking was begun in September, 1931, and has been received with appreciation by many of the Institute men who are in electrical engineering teaching. The Department is anxious to include on the mailing list all the men who have studied in electrical engineering at the Institute and who are teaching. If any such individual has not received the material sent out in September and November, it is an oversight in the mailing list and will be rectified upon notification to that effect being sent to Professor Dugald C. Jackson, Head of the Electrical Engineering Department.

Alumni Dinner

EVERY Alumnus who can get to Boston is invited to be present at the Annual Dinner of the Alumni Association on the evening of February 6. It will be held at the Hotel Statler.

There is to be a reception before the dinner, beginning at 6:15, in the Assembly Room, adjacent to the main ballroom at the Statler. At this reception Alumni and their guests will have an opportunity not only to meet each other, but to meet officials of the Institute and Corporation as well.

During the course of the dinner, the Van de Graaff 1,500,000-volt generator will be exhibited and described for the first time in Boston. In addition to this there will be another scientific demonstration staged by Professor Ralph D. Bennett of the Department of Electrical Engineering and Professor Bertram E. Warren of the Department of Physics.

The speaking program consists of only two speeches; one by President Compton on the educational policy of the Institute, and the other by Dr. Allan Winter Rowe, '01, on undergraduate activities. After these two addresses, the last items on the program, there will be dancing in the ballroom.

Alumni are invited to bring their wives and women friends. The Committee on Assemblies considers it particularly desirable that ladies be present. Tickets may be obtained by calling or writing to the Alumni Association office, Room 3–225, M. I. T. The price per person is $4.00.

Olympic Tryouts

ALUMNI of the Institute will have an opportunity to see some of the nation's finest fencers in action on the evenings of February 10 and 11, when the National Olympic Foils tryouts are to be held in Walker Memorial. In these tryouts the Institute will be particularly well represented. The present national champion is George C. Calnan, '23, and the runner-up is Joseph L. Levis, '26. Levis has been runner-up for four years and national champion for one. He holds the further distinction of being the only American to have reached the finals of an Olympic Foils match, a feat he achieved at the last Olympics. While he was at the Institute, he won the intercollegiates twice.

Levis will participate in the trials at Walker Memorial and there are entries from M. I. T., Harvard, Boston College, Boston University, Boston Athletic Association, and the New York Clubs. In addition to these scheduled foils tryouts, there will be exhibition matches in sabre and epée. Georgio Santelli of New York, Olympic sabre coach, Robert Grasson, coach at Yale, and Rene Peroy, Harvard Coach, have been engaged to perform in the exhibition. Tickets may be obtained by writing or calling the Alumni office. The price per ticket is $1.00 which gives admission to both evenings.

TRANSATLANTIC

(*Concluded from page 218*)

dimension. To me this seemed highly improbable, owing to the fact that the group of capacity has only a finite set of parameters, while the other notions have much more extensive groups. I finally won Menger over to my way of thinking, at least tentatively.

I do not think it at all an accident that many of the mathematicians of the abstract school are at the same time enthusiastic admirers of the more modern directions in art. The modern woodcut, with its sharp contrast of whites and blacks, its severely schematized faces and landscapes, buildings and machines, waves and clouds, its universal moral or social lesson, its thoroughgoing suppression of all suppressable detail, is the precise counterpart of the gaunt, stark, logical skeleton which is all that the abstract schools would leave us. To one of my somewhat naïve intellectual make-up, who likes art to have a little more of the pictorial and a little less of the symbolic than is now the fashion, who rereads his Thackeray a 50th and 60th time — to such a solitary straggler from the Nineteenth Century, a mathematical work cannot be fully satisfactory unless it possesses a certain body and substance, a certain wealth of concrete results, a certain complex interlocking of formulae to give well-rounded theorems — in short, a certain content. However, *de gustibus* —.

The Hamburgers — I am speaking of the analysts, for the canons of geometrical taste are for me a sealed book — seem to have their feet pretty well on the ground. Artin — he is dean at 30 — works more in an algebraically number-theoretic direction, but his powers in analytic number theory are immense. Hecke represents more of the Hardy-Littlewood standpoint. At both Hamburg and Vienna I observed a number of exceedingly keen youngsters, and if working conditions remain reasonably tolerable, the mathematical productivity is provided for for some time to come. Indeed, I hear complaints everywhere that the bad times are sending to the universities thousands of students who never can hope for suitable positions, and who form a discontented intellectual proletariat. Only the unusual man can succeed.

Next month I shall write about Prague, Leipzig, and possibly Berlin. Then, back to Cambridge once more!

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ENGINEERS AS CITY PLANNERS

(*Concluded from page 200*)

extraordinary stimulus to German city planning. In these settlements, an outcome principally of the great work of the Ruhr district, was shown what great economic, social, and scenic advantages can result when the quarters are planned and projected on a large scale. Dwelling construction following this scheme has constantly increased and resulted in the erection of rentable homes which are not single houses but great buildings with accompanying recreation grounds.

The liberation of dwelling construction from historical bonds, in particular from the enclosed block form of the Eighteenth Century, and the carrying out of the "row" method with its mechanical location of buildings and streets, has opened to engineering still another broad field.

At present many scientific investigations are concerned with the proper location of buildings with regard to entrance of sunlight and air based upon varying width and relation to the meridian.

Further researches deal with the possibility of rational opening out of living districts and their complete isolation from traffic routes to insure quiet and freedom from dust. Still others seek to establish a ratio between floor area of dwellings and the sum of public and private free ground area, to avoid a too heavily settled section in residential districts.

The work of the engineer in the field of city planning is directly proportional in its growth to the rate at which modern municipal design is freed from historical influences. Thereby is shown to an ever-growing extent that simplification and articulation, brought into the present-day city picture by the engineer, meet with a natural process of crystallization of the city organism. The way to technical clarity proves to be a way to beauty, which happily solves the problem of harmonious incorporation of the modern city with the surrounding landscape.

BACK TO LEIBNIZ!

(*Continued from page 203*)

to mathematical physics; namely, the principle of least action. This principle, which to the present day is central in quantum theory as well as in the more classical forms of mathematical physics, was a direct deduction from the metaphysics of Leibniz. Leibniz asserts that this world is distinguished from other possible worlds by the realization of some perfection. Maupertuis asks himself what perfection the Newtonian physics actually realizes. In the course of these investigations, it becomes apparent that a certain quantity formed by the integral of the energy with respect to the time, and known as the action, is smaller over the actual path of a particle than over any possible alternative path. Accordingly, Maupertuis takes this to be a sign that God in creating the world has done it with the greatest possible economy of effort.

From one standpoint, this is utter anthropomorphic trash, but it leads to sound physics and originates from a very profound principle, which has modified the entire course of science. This conception (*Concluded on page 224*)

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BACK TO LEIBNIZ!

(*Concluded from page 222*)

of the world as one of a system of possible worlds is vital to the whole of modern mechanics. In the form of the principle of least action, the other possible worlds are introduced merely to be rejected, for they do not satisfy the desired principle of minimization. On the other hand, in a statistical mechanics — the quantum theory reduces the whole of physics to a form of statistical mechanics — these other possible worlds are considered from the standpoint of probability. To put it crudely, the propositions of statistical mechanics assert nothing about any individual possible world, but rather about the overwhelming majority of all of them. This concept, without which modern physics could not have assumed anything like its present form, is a definite part of the philosophy of Leibniz.

UP TO the present, we have chiefly emphasized the resemblances between Leibnizianism and modern physics. It is worth while pointing out that there is one point in which he is more remote from the modern standpoint than was Newton. This point concerns the relativity of motion. It is, of course, a mistake to attribute to Einstein the origination of all considerations as to the relativity of motion. There is a Newtonian relativity just as well defined as that of Einstein and quite analogous to the latter. Indeed, Einstein's chief service has been to show how the Newtonian relativity of rest and motion, which had been compromised by the phenomena of light and electromagnetism, may be supplanted by another form of relativity, in which mechanical phenomena are electromagnetic corollaries.

Now, Leibniz's metaphysical prejudices did not permit him a whole-hearted acceptance of Newtonian relativity. As his monads were self-contained substances, each containing the causes of its entire future history, and as he viewed these causes as of the nature of energy, it became necessary for him to localize energy in individual particles. However, neither Newtonian nor Einsteinian relativity permits the sharp localization of energy.

Nevertheless, Leibniz did play with the idea of relativity — in his less consistent moments — and in one respect went further than Newton. Newtonian relativity, like the special relativity of Einstein, is a relativity as regards uniform translation, but not a relativity as regards rotation, or as regards accelerated motion. There is a real distinction between the shape of the surface of the water in a bucket when it is whirling and when it is at rest, and this cannot be explained away by any transformation of coördinates, without the introduction of new forces. Leibniz felt, nevertheless, that there was some way of treating the distinction even between rotation and rest as relative, and in this history has substantiated him. It was a consideration of this type which led Einstein to seek the meaning of gravity in the geometrical nature of the space-time world, and which was responsible for the concept of general or gravitational relativity.

In conclusion, it may be worth our while to ask why it is precisely Leibniz who is of interest to us in our present phase of physics and why it is exactly our present phase of physics to which the work of Leibniz is relevant. The answer to this is to be found in the fact that Leibniz and the present generation of physicists frame the period of the triumphant success of Newtonian theories. Leibniz's precise physical views were almost immediately eclipsed by the compact Newtonian system which enjoyed 200 years of unquestioned acceptance and ever-increasing achievement. It was not until the beginning of the present century that the technique of physical observation became sufficiently developed to suggested serious shortcomings in Newtonian mechanics. Leibniz wrote at the termination of the pre-Newtonian period of groping and confusion, and it is now the post-Newtonian period of groping and confusion in which we are enveloped. Thus, we are again prepared to find more suggestion in general philosophical considerations than in a great finished discipline which the years have squeezed dry. Leibniz wrote unprejudiced by the success of a single theory, and we again find it necessary to escape from the blinding glare of a theory to see our physical universe face to face and free from prejudice.

ATHLETICS AND HEALTH

(*Continued from page 211*)

as more susceptible to injury through exercise, a position which he reaffirms in a later communication.[4] This point of view is dealt with by White [19] who states

> Physical work and exercise do not cause heart disease although they may precipitate or aggravate symptoms and signs of heart diseases already present and may temporarily exhaust the cardiovascular reserve even in a healthy individual.

In this, as in an earlier article,[20] he regards as unsettled the question of cardiac hypertrophy resulting from exercise. The following excerpts may be quoted:

> There is still some doubt about the possibility of the heart's enlarging as the result of exercise. Abnormal hearts undoubtedly may enlarge, both acutely and chronically, but the normal heart probably increases only a little in size at most; its reserve is great. DeMar . . . shows no cardiac enlargement . . . ; there may be slight enlargement of the heart in professional cyclists, oarsmen and ski-racers.
>
> The poor physical condition resulting from total abstinence from exercise is not conducive to the best of health.
>
> The so-called *athletic heart*, as I have seen it, has consisted simply in effort syndrome or in an 'irritable heart' in a nervous overtrained or undertrained person and not in heart disease.

Bock [23] has also made numerous studies on the physiology of exertion and in them has included records from DeMar, the marathon runner. He points out that:

> It has been shown that glycogen is the sole source of muscular energy. During moderate work the transformation of fat is going on to keep the Respiratory Quotient low. If heavy work is done, then little fat can be utilized, glycogen is used almost entirely, and the Respiratory Quotient tends to approach one. Demar works better not only because of increased space for diffusion in his lungs, the better heart action, etc., but the muscle cells are able to take care of products of increased metabolism without losing them into the circulation, causing fatigue.

Reid [24] in his book on the heart analyzes a large amount of data and concludes that the heart is not the sole factor in enabling the body to accomplish physical labor.

(*Continued on page 225*)

ATHLETICS AND HEALTH

(*Continued from page 224*)

. . . it is now realized that dilatation of the heart may be a purely physiological process, and thus the fear of this feature has been much lessened.

Elsewhere he analyzes the mechanism of cardiac response to exercise.

There is evidence that during exercise there occurs a dilatation of the peripheral blood-vessels, produced in large part at least by the coöperation of the nervous system, probably a reflex through the depressor fibers of the vagus nerve. This dilatation of the peripheral stream bed causes a more rapid drainage of blood away from the heart, and lessens the rise of pressure in the first part of the aorta, and also the height of that which must be achieved in the left ventricle before the aortic valve can be forced open. During exercise, therefore, the heart is thus enabled to contract without strain.

The studies of Himwich and Barr [25] offer material confirmatory of these last general conclusions.

The mobility of red corpuscles with their oxygen-carrying hemoglobin, the stretching of the alveolar membranes through the more vigorous breathing, and the consequent better diffusion into the lung, all contribute to enable the blood to retain more oxygen.

Indeed the investigations of Himwich and Barr lead them to the unanticipated conclusion that perhaps the severity of the exercise that a normal person will tolerate may be determined by the amount of oxygen that can diffuse through the lung membrane rather than by the capabilities of the circulation.

Most recently, a very thorough and comprehensive survey of many of these problems has found place in the authoritative revision by Bock and Dill [26] of Bainbridge's well-known treatise on the physiology of muscular exercise. But a few excerpts among the many need be quoted

At the risk of repetition it is worth pointing out again that no system or mechanism in the body can be isolated from the whole, but that as a general principle the entire body participates in reactions which lead, through training, to greater physical power.

Consideration of two great systems in the body serves to indicate that the question of exercise is not concerned alone with the problem of breathing or the capacity of the heart. Too much emphasis has in the past been applied to the question of heart strain, the heart being considered as the limiting factor in exercise.

The limit of exercise has often been ascribed to the capacity of the heart alone, but the facts as a whole indicate that the sum of the changes taking place throughout the body brings about the final cessation of effort.

The better coördination of movements, which is brought about by training, also improves the mechanical efficiency of the body. The effect of these changes is not only to increase a man's power, but also to enable him to carry out his work, whether heavy or light, with the greater economy of effort.

It is concluded that there is no evidence at present that the longevity of athletes is altered by physical training and participation in sports.

To summarize briefly, the question of cardiac enlargement as the result of competitive exercise would still seem to be unsettled. On the other hand, hypertrophy, should it occur, does not seem to connote cardiac disease *per se* and there would seem to be an unanimity of opinion that exercise does not produce heart disease. Further injury to an already injured heart is conceded; the initiation of a morbid (*Concluded on page 226*)

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ATHLETICS AND HEALTH

(Concluded from page 225)

process is denied. The only recent dissenting voice is that of Dublin [7] who bases his opinion on a statistical analysis, the details of which present anomalous and self-contradictory features.

From this it would seem to the dispassionate observer that, in the health control of college athletics, it is only necessary to insure the prospective contestant from existing cardiac pathology. The medical examination by a competent practitioner, specially trained in this field and utilizing such additional laboratory procedures as modern science has contributed to modern medicine, should prove a wholly effective insurance against an unwise indulgence. To deny any healthy lad participation in competitive sport, that most normal and wholesome of recreations, would seem to be unwarranted. By safeguarding the unfit, the field is left open to the boy who can derive only health and pleasure from the exercise of his physical powers.

[1] Schumacher and Middleton, *Journal American Medical Association* (1914), 62–1136.
[2] Lee, Dodd and Young, *Boston Medical and Surgical Journal* (1915), 173–499.
[3] Meylan, *Harvard Graduate Magazine* (1904), 12–362 and 543.
[4] Cole, *American Physical Education Review* (1928), 33–571.
[5] Greenway and Hiscock, *Yale Alumni Weekly* (1926), 35–1086.
[6] *J.A.M.A.* (1926), editorial, 87–175.
[7] Dublin, *Harper's Magazine* (1928), 157–229.
[8] Gordon, Levine and Wilmaers, *Archives Internal Medicine* (1924), 33–425. See also, Gordon, *American Journal Roentgenology* (1925), 14–424.
[9] Richards, *J.A.M.A.* (1930), 93–1988.
[10] Buytendijk, *Ergeb. d. Sportartzlichen Untersuch. b. d.* IX Olymp Spiel in Amsterdam (1928). Reviewed, *J.A.M.A.* (1930), 95–1950.
[11] Herxheimer, *Zeitschrift Klinische Medizin* (1923), 96–218.
[12] Ibid., *Klinische Wochenschrift* (1924), 3–2225.
[13] Hahn, Herxheimer and Brose, *Deutsche Medizin Wochenschrift* (1925), 51–892.
[14] Herxheimer, *Klin. Woch.* (1926), 5–749.
[15] Ibid., (1929), 8–402.
[16] Dedichen, *Acta Medica Scandinavica* (1921), 53–738.
[17] Barringer, *J.A.M.A.* (1921), 76–1143.
[18] Cole, *American Phys. Ed. Rev.* (1922), 27–475.
[19] White, "Heart Disease" (Macmillan: New York, 1931).
[20] Ibid., *New England Journal Medicine* (1928), 199–801.
[21] Dwight, "The Next Job in Preventive Medicine," *Life Insurance Medicine* (New England Life Insurance Co.: Boston 1926), p. 22.
[22] Farrell, Langan and Gordon, *American Journal Medical Science* (1929), 177–309.
[23] Bock, *N. E. J. Med.* (1928), 198–269.
[24] Reid, "The Heart in Modern Practice" (Lippincott: Philadelphia, 1928), second ed., 369 and 357.
[25] Himwich and Barr, *Journal Biological Chemistry* (1923), 57–363, quoted in *J.A.M.A* (1923), editorial, 81–.
[26] Bainbridge, "The Physiology of Muscular Exercise" (Longmans, Green: London, 1931), third ed., rewritten by A. V. Bock and D. B. Dill.

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THE REVOLUTION ON THE RIALTO

(*Continued from page 208*)

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Prominent among such changes and developments is the increasingly large number of cases where active control and management is quite completely divorced from the responsible proprietary interest. (*Concluded on page 230*)

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THE REVOLUTION ON THE RIALTO

(*Concluded from page 228*)

American corporations afford numberless examples of the almost complete separation of the proprietary interest from the group who exercise the power of selecting the active management. The situation has operated to contravene our whole philosophy of proprietary control, which is based upon a proper balancing of the rights, duties, and responsibilities which attach to the ownership of private property. Moreover, ownership — true proprietorship — is, by this development, reduced to a state of dependence on those who exercise the functions of management and control. Disenfranchised owners, like the detached labor groups, have seen their power and strength pass to those in whose hands rests the control of the means of production.

Most of the important changes that have taken place on the financial side of industry during the last decade, are traceable to the culmination of the long price cycle which began in the nineties, reached its peak in 1920, was extended beyond its time by the post-war speculative boom, and finally crashed to present extreme low levels during the year just closed. The closing phase of this price change was accompanied by a world condition which brought America over half of the existing supply of monetary gold and furnished the base for an almost limitless expansion of credit. In this set of circumstances may be found the influences which have brought about a vastly over-extended plant development, a veritable flood of corporate securities that have grossly overcapitalized normal earning power, the emergence of numerous non-economic ventures under the pressure of redundant capital and credit-seeking employment, the growth of unwise (not to say unsound) banking associations in the form of security affiliates and investment trusts, and finally an expansion in foreign investments quite beyond the limits set by sound business judgment.

Such an array of somber details forms a rather dismal picture. But the inexorable and irresistable laws of economic behavior are even now at work bringing order out of what seems to be chaos. Slowly, by the painful process of elimination, over-expansion of plant capacity is being corrected. This process is retarded by the important fact that though the company may fail the plant remains, and after a financial readjustment and with a greatly reduced burden of capitalization, it emerges as a more severe competitor than before. The larger the proportion of capital invested in plant and equipment, the slower the adjustment through economic depression.

Gradually, however, the corrective process is going on. The enlarged stock and bond issues which were put out to keep pace with the rising profits that always accompany a period of advancing prices will be scaled down to a level commensurate with normal earnings. Many corporations will go "through the wash;" others will effect voluntary retirements of a part of their capital obligations; while others will reverse the stock split-up game and consolidate their outstanding shares on some convenient and proper ratio.

Leading American corporations took advantage of the new era, when common stocks were being feverishly bought as investments, to retire their funded debt. Many converted their surpluses into cash or cash equivalents and we have today the unusual spectacle of numerous companies whose shares are selling in the market for but little more than their net working assets. Such companies are, therefore, in an excellent position to take advantage of the business revival which is certainly ahead of us. The banking situation is fundamentally sound and is in a fair way to correct the errors of the recent past. The financial structure of American business will emerge from the present painful period safe, sturdy, and strong.

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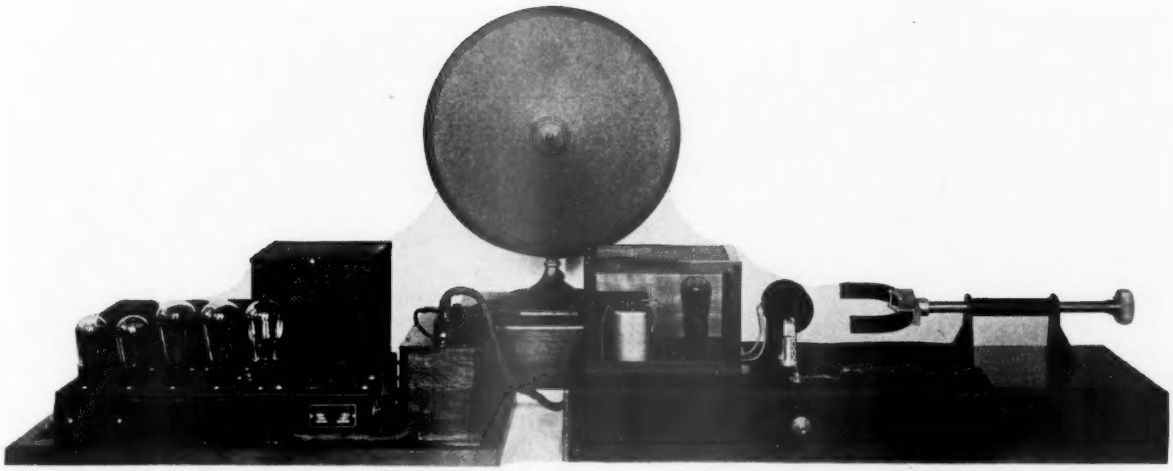

Permitting the public to hear the squirming of molecules! This "Barkhausen Effect" Model is one of a series made for the New York Museum of Science and Industry. It gives experimental support to one theory of magnetism. As displayed, the amplifier at the left of the picture is mounted behind the scenes. Two other models of this series are shown below

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THE New York Museum of Science and Industry, 220 East 42nd Street, New York City, is opening a new section dealing with magnetic and electrical phenomena. We urge you to visit this exhibition — (which contains more than 20 of our working models) — as we are confident it will prove interesting to you.

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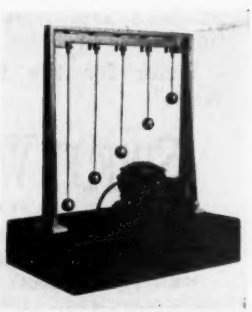

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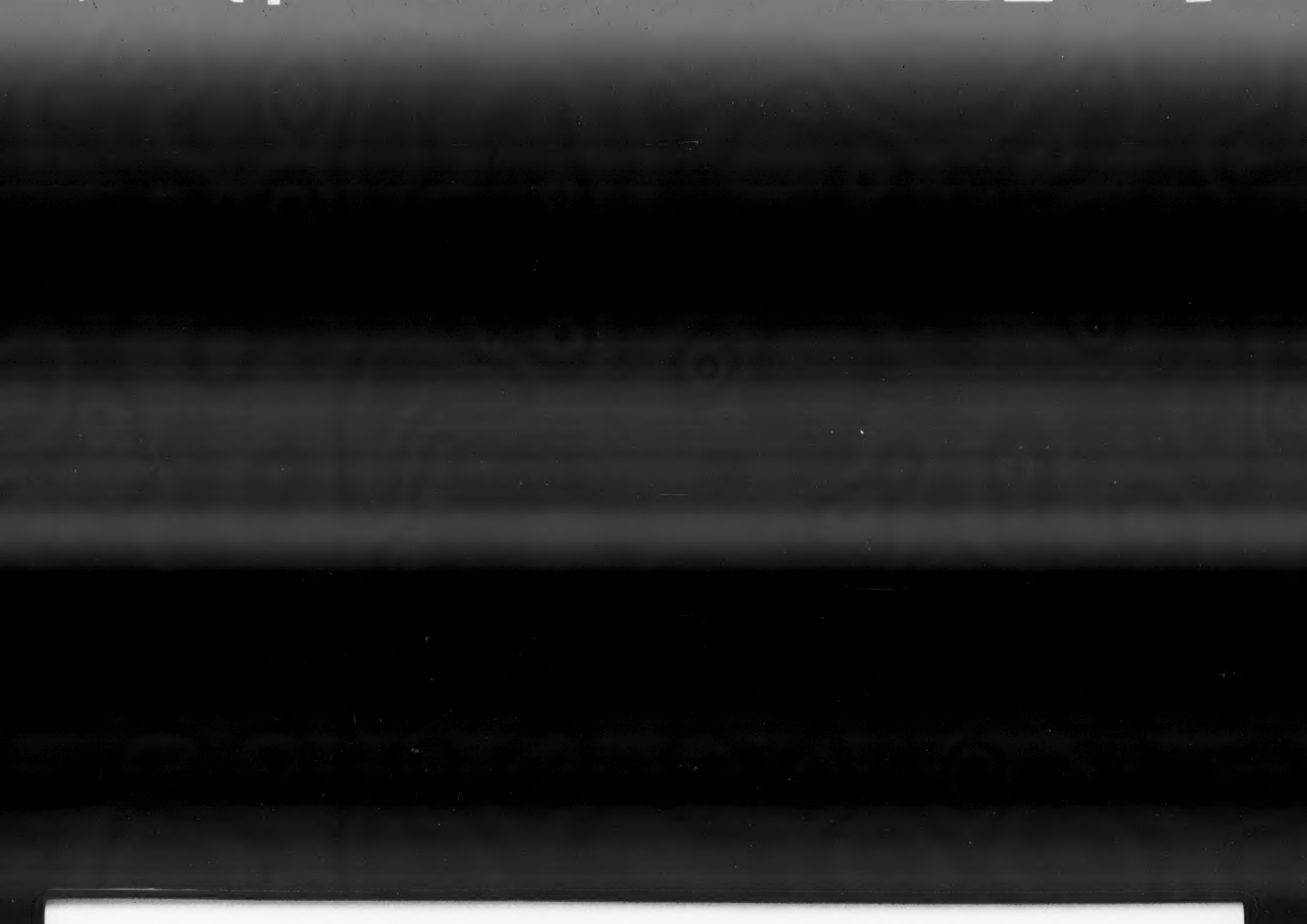
THE TABULAR VIEW

THE discussion on page 242 by Dr. KARL T. COMPTON, President of the Institute, is a notable contribution to the literature on technical and scientific education. It takes into consideration not only the situation as Dr. Compton has found it here at M.I.T., but the general aspects of the problem as it exists in all colleges where instruction is given in science and engineering. It has even a more general appeal, for it discusses the value of scientific and engineering education as compared to a purely liberal arts course of study.

PRESIDENT HOOVER'S Conference on Home Building and Home Ownership created a widespread interest in the more scientific and technological aspects of the design and equipment of small houses, and many people are vitally interested in new developments in this field. The question as to what direction improvements are to take was submitted by The Review to JOHN E. BURCHARD, 2D. The result is the very provocative article beginning on page 239. ¶ Mr. Burchard is well equipped to discuss the future of the home, having been associated for a number of years with the Housing Company of Boston which has been conducting pioneer and fundamental research in new methods and materials for building. Besides Mr. Burchard's professional work as Director of Research and Development of the Bemis Industries, Inc., he likewise has had a great variety of experience in academic work. A graduate of the Institute in the Class of 1923, he subsequently taught a short while in the Department of English, followed by a period as an instructor in structural design in the Department of Architecture. To the January, 1932, issue of *Architectural Forum*, he contributed "The Economic Thickness of Thermal Insulation," a paper which presents a formula for determining the insulation thickness which may be used by architects for any locality and under any given conditions.

INDUSTRIAL EQUILIBRIUM, by ROBERT F. ELDER, concludes the series of articles that have been published in The Review on current economic and business problems. Professor Elder received his A.B. degree from Harvard University in 1922, joining the Institute staff in 1929 as an instructor in marketing. The following year he became Assistant Professor of Marketing. In 1928, he won the Alvan T. Simond's Prize for a paper on "Reducing the Cost of Distribution." He has also written for publications of the American Management Association and a series of articles for *Factory and Industrial Management* on the Relation of Production and Distribution, which appeared under the general title of "Coördinating Sales and Production." ¶ In a forthcoming issue, The Review will present a discussion of German technical education prepared by two prominent German engineers. There will also be an important article on the history of computating ("thinking") machines, another on new developments in chemistry, and, of course, the usual departments.